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PROGRESS REPORT ON RESEARCH AND RELATED SERVICE
APPLICABLE TO
FOOD AND NUTRITION

Including Work in United States Department of Agriculture
and Cooperative Studies with
The State Experiment Stations

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Prepared for Use in Connection with the
November 1955 Meeting of the
Food and Nutrition Research Advisory Committee

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This Progress Report is a "tool" for: (1) Advisory Committee use in form-
ulation of recommendations in regard to present and future programs;
(2) Administrative use in program development, coordination and evaluation.
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also are many tentative findings that have not been sufficiently tested
for public release. When results are ready for release, the information
will be made available through established channels.
For the reasons given, copies of the Report are available only to research
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FUNCTIONS OF ADVISORY COMMITTEES

The Food and Nutrition Research Advisory Committee is one of a number of committees authorized by Congress in 1946 to advise the Department of Agriculture with respect to specific research and service programs.

The committees have been asked to consider all of the research and marketing service work of the Department in their respective fields. This is in recognition of the value the Department places upon the advice and counsel received and is in accord with suggestions of Congressional committee members who are directly concerned with the work.

These committees are performing an important function in advising with respect to the development of the Department's research and marketing service programs. However, it is recognized by members of Congress, committee members, and the Department that the implementing and administering of these programs are the responsibility of the Department.

The functions of the advisory committeemen include:

1. Acquainting themselves with the problems of consumers, producers, all segments of the industry and of other groups, and presenting them for committee consideration.
 2. Reviewing and evaluating the current research and marketing service programs of the Department, including work under way at Federal laboratories and field stations.
 3. Recommending adjustments in the Department's program, including priorities for new work and expansion of work under way.
 4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested persons, groups and organizations and encouraging the wider and more rapid application of the findings of research.
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COOPERATION

Much of the research on food and nutrition covered in this report is conducted in cooperation between agencies of the United States Department of Agriculture and the State Experiment Stations. The studies find their origin in problems of producers, processors, distributors and consumers, and representatives of these groups frequently participate in the cooperation: Cooperative programs are jointly planned and conducted in a manner to make full use of the personnel and resources of each participating group with the minimum of duplicative effort. The results of cooperative research are jointly prepared in the form of uniform recommendations.

* * *

USDA Agencies responsible for conducting or supervising the work outlined in this report are indicated by initials as follows: (Unless otherwise noted these are Branches of the Agricultural Research Service (ARS), or of the Agricultural Marketing Service (AMS).)

ADP	Animal Disease and Parasite Research Branch	(ARS)
BS	Biological Sciences Branch	(AMS)
DH	Dairy Husbandry Research Branch	(ARS)
ENT	Entomology Research Branch	(ARS)
FD	Food Distribution Division	(AMS)
FES	Federal Extension Service (Independent)	(FES)
HC	Horticultural Crops Research Branch	(ARS)
HN	Human Nutrition Research Branch	(ARS)
MD	Market Development Branch	(AMS)
OC	Market Organization and Costs Branch	(AMS)
SHR	Statistical and Historical Research Branch	(AMS)
SWC	Soil and Water Conservation Research Branch	(ARS)
WU	Western Utilization Research Branch	(ARS)

TABLE OF CONTENTS

		<u>Pages</u>
I.	<u>FOOD COMPOSITION IN RELATION TO NUTRITIVE VALUE</u>	
A.	PROGRESS ON WORK UNDER WAY	1 - 4
	1. Pantothenic acid in foods	1
	2. Proximate composition of foods	1
	3. Increasing Vitamin C content of potatoes	2
	4. Amino acid composition of turnip greens in relation to plant nutrition	2
	5. New amino acid discovered in turnips	2
	6. Nutritive value of turnip greens in relation to plant environment and soils	3
	7. Vitamin B12 potency of cheese and other dairy products	3
	8. Relative nutritive properties of butterfat and vegetable fats	3
B.	PROPOSALS FOR COMMITTEE CONSIDERATION	45 - 47
II.	<u>FOOD QUALITY AND HOUSEHOLD USE</u>	
A.	PROGRESS ON WORK UNDER WAY	5 - 18
	1. Effects of pesticides on food quality and flavor	5
	2. Yields of food in institutional preparation	12
	3. Adequacy of cooking procedures for destruction of Salmonella	12
	4. Flavor and cooking quality of eggs	13
	5. Cooking methods for beef of low market grades	15
	6. French frying quality of potatoes	16
B.	PROPOSALS FOR COMMITTEE CONSIDERATION	45, 50, 51, 52, 53, 54, 55, 56, 57, 58
III.	<u>HUMAN NUTRITION</u>	
A.	PROGRESS ON WORK UNDER WAY	19 - 25
	1. Fatty acid requirements	19
	2. Amino acid requirements	20
	3. Influence of carbohydrates on amino acid requirements	20
	4. B-Vitamin requirements	20
	5. Balance among nutrients in diets	21

III. HUMAN NUTRITION (Continued)

A. PROGRESS ON WORK UNDER WAY (Continued)

6. Heights and weights of children	22
7. Diets and nutritional state of individuals	22
8. Reference diet for human nutrition research	25
9. Other research on human requirements and availability of nutrients	25

IV. FOOD CONSUMPTION AND DIETARY LEVELS

A. PROGRESS ON WORK UNDER WAY 26 - 37

1. <u>National Food Supply</u>	26
a. Changes in supply and use of farm products	26
b. Trends in food consumption	26
c. Marketing studies on economic loss and wastes	26
2. <u>Household Food Consumption</u>	27
a. 1955 food consumption survey	27
b. Food consumption of rural families	27
c. Household food losses	28
3. <u>Diet Appraisal</u>	
a. Amino acid tables	29
b. Food refuse, yields and nutritive value	30
c. Basic data for food and nutrition programs	30
d. Facts for consumer education	30
e. Services to Nutrition Committees	31
4. <u>Food Purchases and Preferences</u>	32
a. Purchasing practices of industrial eating establishments	32
(1) Industrial feeding facilities	32
(2) Use of frozen foods	32
b. Household purchases of butter, cheese, nonfat dry milk solids and margarine	34
c. Institutional markets for fresh and processed foods	34
d. Consumer purchases of fruits and juices	34
e. Consumer retail acceptance of fat versus lean pork	34
f. Consumer preference for white pan bread	35

IV. FOOD CONSUMPTION AND DIETARY LEVELS (Continued)

A. PROGRESS ON WORK UNDER WAY (Continued)

4. Food Purchases and Preferences (Continued)

g. Consumer preference for canned citrus juices	35
h. Consumer use of and preferences for peanuts and tree nuts	35
i. Consumer use of and preference for selected cuts of lamb	35
j. Consumer use of and opinions about cherries in home baking	36

B. PROPOSALS FOR COMMITTEE CONSIDERATION	48, 49, 50, 52
--	-------------------

V. RESEARCH AND EDUCATIONAL WORK ON BROAD OR GENERAL
WELFARE PROBLEMS

A. PROGRESS ON WORK UNDER WAY	37 - 44
-------------------------------	---------

1. Food Distribution 37

a. National School Lunch Program	37
b. Special School Milk Program	37
c. Direct Distribution	38

2. Federal Extension Service and its Functions in
Educational Work in Foods and Nutrition 38

a. Home Economics Programs	38
b. Foods and Nutrition Program	40
c. Agricultural Economics Programs	43

I. FOOD COMPOSITION IN RELATION TO NUTRITIVE VALUE

A. PROGRESS ON WORK UNDER WAY

1. Pantothenic Acid in Foods

HN

The quantitative distribution of pantothenic acid in 237 food items has been determined by laboratory analyses using the previously reported standardized microbiological procedure shown to yield reliable data as checked by bioassay. A report has been prepared for publication giving values for the foods analyzed and description of the method used. On a fresh weight basis, liver and kidney were high in pantothenic acid, averaging 75 and 40 micrograms per gram respectively; meats and poultry averaged 9 micrograms; eggs, 16 micrograms; nuts, 8 micrograms per gram. Dried peas and whole wheat averaged 21 and 10 micrograms per gram respectively. Milk, cheeses and fresh vegetables generally contained about half as much pantothenic acid as meats. Fresh fruits generally had about half the pantothenic acid content of fresh vegetables.

Plans: Continued work on the B-vitamins will be directed toward obtaining reproducible responses of test organisms in microbiological methods for the determination of vitamin B₆ and vitamin B₁₂ in foods. After the development of standardized procedures, their systematic application to common foods will be made.

2. Proximate Composition of Foods

HN

In conjunction with new work on determining the mineral and b-vitamin content of foods, laboratory analyses have been started to obtain proximate composition data systematically on all foods analyzed for other nutrients, and on new foods for which data are lacking or believed to be inadequate. For these analyses, a modified method is being used for fat extraction which has been found to give up to 20 percent higher values for fat in food composites and carbohydrate-containing mixtures than does the Soxhlet ether-extraction procedure.

Plans: As staff time permits, selected foods will be analyzed for crude fiber, starches and sugars, using methods recently standardized in Branch laboratories. New data on fat content and on available carbohydrates in foods will provide much-needed bases for more reliable figures on the calorie values of foods, for use in food composition tables and in appraisal of diets.

Publications:

"Fatty Acid Composition and Oxidative Deterioration during Storage of Fats in Cuts of Beef, Lamb, Pork, and Turkey." O. S. Privett, F. J. Pusch, and W. O. Lundberg. Food Tech. IX, pp. 347-351, July 1955.

"Reduced Ascorbic Acid Values of Thirty-four Foods." K. H. Fisher and M. L. Dodds. Food Res., Apr.-May 1955 issue. (Contract with Pa. State Univ.)

3. Increasing Vitamin C (ascorbic acid) Content of Potatoes

SWC

The study of potato varieties, in cooperation with potato breeders, has continued with the objective of finding breeding material which will transmit high vitamin C content to the progeny. It is essential that horticultural qualities accompany any improvement in nutritive value. A retest of older parents confirmed the previous method of evaluation and the ability of these parents to produce progeny of higher vitamin C content to the progeny. Tubers from one of the selections, KB1377-1, have almost double the ascorbic acid content found in commercial varieties that are comparatively high in vitamin C.

Plans: Continue at present level.

4. The Effects of Macronutrient Element Nutrition on the Amino Acid Composition of Turnip Greens

SWC

Accurate analysis of the non-protein nitrogen fraction of turnip greens has necessitated an extension of existing methods and development of new techniques. Thus, the microbiological methods which require a relatively large amount of sample have been supplemented by chromatographic methods. It is now possible to more accurately determine proline, phenylalanine, tyrosine and histadine. New methods for the separation of leucine and isoleucine and the basic amino acids have been developed and the variables have been ascertained so that the separations are reproducible. Likewise, a method for the separation of amino acids from sugars and salts employing ion-exchange resins has been worked out. With these new techniques, it was found that turnip plants deficient in calcium showed an increase in alanine and proline. Potassium-deficient plants had a high glutamine content but a low glutamic acid content, indicating that potassium is necessary for the utilization of glutamine, but not in its formation from glutamic acid. Leaves of potassium-deficient plants showed a marked increase in glycine. Magnesium-deficient plants showed decreased amounts of alanine and gamma-amino butyric acid and an increase in pipecolic acid.

Plans: Expand concomitantly with vitamin B-12 work proposed.

5. New Amino Acid Discovered in Turnips

SWC

S-methyl cysteine sulfoxide, a hitherto unknown amino acid, has been isolated from the turnip plant. This compound may be a methyl donor and it accounts for a substantial part of the soluble sulfur amino acids in this plant. Its cysteine activity is at present under study. This is the first instance of the identification of a sulfoxide grouping in plants.

6. Effect of Environment and Soils on the Nutritive Value of Turnip Greens as Measured by Growth of Rats

SWC

Additional evidence has been obtained during the past year on the nature of the nutritional difference in turnip greens from two locations in Georgia. Growth data for the chick corroborated the findings for the rat with respect to the nutritive superiority of the Blairville greens. Microbiological assays of the material, studies of the liver stores of vitamin B₁₂ in the chicks used in a B₁₂ assay of the greens, and the growth data of both rats and chicks indicate the presence of nutritionally significant amounts of a "B₁₂-like" substance in the Blairsville greens. Furthermore, there is a suggestion that there is a constituent in the turnip greens from Experiment that may be slightly toxic to both the rat and chick.

Plans: Continue at present level.

7. Vitamin B₁₂ Potency of Cheese and Other Dairy Products

DH

Further comparative rat and microbiological (*L. leichmannii*) assays for vitamin B₁₂ have been made on additional lots of cheese and other dairy products. In the case of cottage cheese the two methods yielded, on the average, about the same results. With natural Cheddar, process Cheddar, natural Swiss and process Swiss cheese, the rat assay indicated 50% to 100% greater potency than the microbiological assay.

By rat assay, 9 lots of natural Cheddar cheese averaged, in micrograms of vitamin B₁₂ per kilogram, 20.8 (range 12-29); 5 lots of process Cheddar, 12.0 (range 9-14); 2 lots of process cheese food, 8 and 9; 1 lot of process cheese spread, 5; 6 lots of natural Swiss, 36.2 (range 22-54); 5 lots of process Swiss, 18.4 (range 10-29); and 5 lots of cottage cheese, 8.0 (range 5-10).

On a dry matter basis, natural Cheddar, process Swiss and cottage cheese possessed about the same B₁₂ potency, whereas process Cheddar had about half and natural Swiss about one and three-fourth times the potency of the above three cheeses.

Other dairy products by rat assay yielded the following results: dried whole milk (2 samples), 39 and 36 mcg/kg, dried skim milk (3 samples), 42, 39 and 37 mcg/kg.

Plans: Further work should be done to determine the cause of the discrepancies in vitamin B₁₂ potency of certain types of cheese as determined by the rat and microbiological (*L. leichmannii*) assay methods. Another microbiological method employing Ochromonas malhamensis should be tried in comparison.

8. Relative Nutritive Properties of Butterfat and Vegetable Fats

DH

Workers at Minnesota (*J. Nutrition*, 52: 613 (1954)) found that when a bacteriostatic agent (sulfathalidine) was included in a purified ration containing 28% corn oil, a depression in growth of weanling

rats resulted which could be partially counteracted by replacing corn oil with butterfat.

In work in this branch, similar comparisons with rats were made with a basal ration patterned after the ration used at Minnesota. No consistent differences between corn oil and butterfat have been observed in the absence of the sulfa drug. In a series of experiments with sulfathalidine in the ration, however, butterfat was always found to promote higher average weight gains than corn oil. These differences were observed only during the first few weeks on experiment, the weight gains after that time being essentially the same for the two fats. Another vegetable oil (cottonseed oil) was found to give results similar to corn oil. On the other hand, a hydrogenated vegetable fat (margarine fat) gave results similar to although, in some experiments, not quite as good as butterfat.

The interpretation of the results is complicated somewhat by the fact that the basal ration has been found to be inadequate in protein content, although when the protein level was increased, differences between corn oil and butterfat were still obtained. Another complication in the interpretation of the results obtained has been the tendency for the liquid vegetable fats to separate out of the ration to a limited extent at this high fat level.

Plans: Continue studies in an effort to determine the influence of these complicating factors on the results obtained and to determine what factor or factors may be responsible for the differences in growth response brought about by the various fats. The comparative nutritive value of the various fats incorporated in this high fat diet also is to be studied in regard to reproduction and lactation of rats.

II. FOOD QUALITY AND HOUSEHOLD USE

A. Progress on Work Under Way

1. Effects of Pesticides on Food Quality and Flavor

ENT, ADP,
DH, HN

The production of marketable vegetables, fruits and other agricultural products is dependent upon the judicious use of a variety of potent insecticides. The insecticidal residues and the effects on quality and flavor resulting from the use of insecticides bring forth new problems each year and research investigations are undertaken to solve them as a part of the overall program to develop safe and effective chemicals for controlling insects affecting plants and animals. The main objective is to obtain commercial control of destructive insects without leaving injurious residues or adversely affecting the quality or flavor of crops or products derived from crops.

The passage of Public Law 518 and subsequent announcements by the Food and Drug Administration, HEW, of tolerances for pesticide chemicals effective July 22, 1955, unless extended, which are allowable in or on raw agricultural commodities, has increased the demand for data on pesticide residues on fruits, vegetables, forage crops and animal products such as milk, meat, eggs, etc., and in soil.

The residue tolerances established by the Food and Drug Administration are expressed as parts per million (ppm) and they vary depending upon the toxicity of the insecticide and the extent to which various food items are consumed by people. After insecticide tolerances are set by law, any agricultural products found in trade channels that have a residue exceeding such tolerances are subject to seizure and condemnation. Accordingly, many of the residues given in this report in parts per million will assume added importance as soon as tolerances are established for many of the new insecticides now under investigation.

a. Plant Products

ENT; HN

Potatoes: Samples of potatoes receiving two applications of demeton at the rate of 3 ounces and three applications at the rates of 6 and 12 ounces, per acre, per application were appraised by a taste panel in Washington consisting of 60 persons. Only one taster reported an objectional flavor.

Chemical analyses of potatoes from the above treatments revealed demeton residues of 0.21, 0.38 and 0.31 ppm, respectively.

Potatoes from the above treatments plus potatoes from additional plots receiving 32 ounces of demeton per acre, were fed for 30 days to rats and monkeys as the major item of their diet.

The animals gained weight and there was no apparent effect upon the cholinesterase levels of the blood. These tests on animals were conducted by the USPHS in Georgia.

Chemical analyses of potatoes from plots in Washington receiving three applications of schradan at the rates of 16 and 32 ounces per acre had residues of 0.35 and 0.68 ppm, respectively.

Cabbage: In California, samples of cabbage heads from plants receiving demeton dusts at the rates of 5, 10 and 15 ounces, respectively, per acre, were analyzed by commercial chemists and found to contain from 10 to 17 ppm of demeton residues 1 day after treatment; 2 to 9 ppm after 7 days; and 0. to 0.4 ppm after 28 days.

Strawberries: In California, chemical analyses by commercial chemists of strawberry fruits from plants receiving one application of demeton dusts at rates of 6, 11 and 17 ounces, respectively, per acre, showed demeton residues ranging from 0.5 to 1.7 ppm 5 days after treatment and from 0.1 to 0.2 ppm after 24 days.

Sweetpotatoes: Chemical analyses of sweetpotato roots, by the chemists of ENT and of an insecticide manufacturer, failed to disclose the presence of any dieldrin residues in sweetpotatoes harvested 50 to 64 days after treatment from field plots where dieldrin dusts were applied at the rate of 1.5 pounds of dieldrin per acre, for sweetpotato weevil control. Palatability tests by HN of samples of two varieties of sweetpotatoes from treated plots showed no significant evidence of flavor variations attributable to the dieldrin treatment.

Mixed Vegetables: Beet tops, kale, okra pods, snap beans and tomato fruits treated in Maryland with malathion dusts or sprays at the rate of 1.75 pounds of malathion per acre, harvested 1 hour after the insecticides were applied, and washed in plain water for 60 seconds, contained less than 1 ppm of malathion, a level which likely would meet tolerances for this compound on vegetables. Dust treatments on broccoli gave malathion residues of less than 1 ppm but the emulsifiable concentrate and wettable powder sprays gave malathion residues of 2.3 and 1.7 ppm, respectively.

Chemical analyses were made of lima beans, snap beans, Marble-head squash, banana squash, zucchini squash, lettuce, tomato, carrot, pepper, parsnip, peas, cucumber, cantaloup, radish and beets grown in field plots in Washington where 3 and 6 pounds, respectively per acre, of actual heptachlor were mixed in the soil. No heptachlor residues were found except in the carrot at the 6-pound rate and parsnip and radish at both the 3- and 6-pound rates. Most of the heptachlor residues recorded were less than 1 ppm.

The hulls and shelled beans of lima beans from plants in California, treated with toxaphene dusts at the rate of 3.1 pounds per acre, harvested 2 weeks after treatment, were analyzed by the chemists of an insecticide manufacturer. The hulls contained toxaphene residues ranging from 0 to 1.75 ppm and the shelled beans gave residues ranging from 0 to 1.31 ppm, which are well below the legal tolerance of 7 ppm established for some raw vegetables.

Deciduous Fruits: As new insecticides become available they are carefully evaluated as substitutes for or supplements to existing materials for the control of insects attacking deciduous fruits without adversely affecting the appearance or quality of the fruit. Parathion, malathion, methoxychlor, ryania, Diazinon, aldrin, dieldrin, heptachlor, Chlorothion, demeton, Coumpound Am. Cyanamid 12008, Chlorobenzilate, Bayer L 13/59, dichlorophenyl benzenesulfonate, Am. Cyanamid 4124, isodrin, Pirazinon and Strobane are among the experimental materials that are promising for one or more new uses. In a number of instances only lack of adequate residue data delays acceptance for registration and recommendation.

Quality of Citrus: In Mexico and Texas ethylene dibromide may be an effective treatment to insure freedom of Texas grapefruit from Mexican fruit fly infestation without injuring the fruit or affecting its quality. No external injury resulted from effective dosages following treatment of approximately 132 tons of fruit except some rotting due to intensification of processing injury to overripe fruit. Residue analyses of the peel and pulp of treated fruit showed no ethylene dibromide or other bromides after four days.

Corn: Residue analysis of corn plants following application of insecticides for European corn borer control in Iowa indicated that malathion was lost very rapidly. At a 2-pound-per-acre rate the residue was usually below 1 ppm 5 days after application. Where DDT at 1.5 pound per acre was applied as granules and as an emulsion, the residue 5 days after application averaged 1.1 ppm and 142.8 ppm, respectively. The use of granular type insecticides which are highly effective for controlling the insect might also avoid accumulation of excessive residues.

Rice: In Louisiana, rice obtained from plots sprayed with 0.25 pound of dieldrin per acre for rice stink bug control soon after the rice headed (20 days before harvest) showed an average of less than 0.1 ppm of dieldrin in the milled rice, less than 0.5 ppm in the rough rice or in the hulls, and none in the bran.

Plans for Future Work on Insecticidal Residues (Plants):

ENT

A broad program of research will be continued and strengthened to develop spray schedules that will control destructive pests of fruits, vegetables, forage, grains and other crops without adversely

affecting their flavor and quality or contaminating them with harmful residues. Whenever possible studies of the effects of new insecticides on plants and soils and a determination of their residues remaining on different crops will be made as pre-requisites to the development of pesticide recommendations for use on food crops.

Publications:

"Effect of oil and parathion sprays on soluble solids in oranges." A. W. Cressman. Jour. Econ. Ent. 48(2):216-217. 1955

"Flavor and benzene hexachloride content of peanuts grown in rotation with cotton dusted with insecticides containing benzene hexachloride." H. Reynolds, G. L. Gilpin, and I. Hornstein. U. S. Dept. Agr. Cir. No. 952, 26 pp. 1954.

"Five years' results of the effect of certain insecticides in the soil on crop response. W. J. Clore, E. C. Kostermeyer, and W. E. Westlake. Washington State Hort. Assn. Proc. 50(1954); 164-166.

"Reduction of malathion residues on vegetable by washing." F. F. Smith, P. Giang, and E. A. Taylor. Jour. Econ. Ent. 48(2): 209-210. 1955.

"Benzene hexachloride content and flavor of peanuts grown in rotation with cotton dusted with this insecticide." I. Hornstein, H. Reynolds, and G. L. Gilpin. Agr. and Food Chem. 2(15):776-778. 1954.

"Status of analytical methods with respect to the determination of minimal quantities of insecticides." R. H. Carter. Jour. Econ. Ent. (in press).

"Determination of lindane in mushrooms." I. Hornstein. Jour. Agr. and Food Chem. (in press).

b. Animal Products

ENT;ADP;DH;HN

It has become increasingly important to determine the extent to which insecticides store in meat and milk when used on animals to control destructive insect pests or on forage which is fed to livestock. With new insecticides that are being considered for insect control, experimental work to determine hazards to the consuming public is necessary. Several of the older chlorinated hydrocarbon insecticides such as DDT, toxaphene, dieldrin and aldrin cannot be used on dairy cattle since they are secreted in the milk. Some of the newer chlorinated insecticides and the organic phosphorus insecticides show promise of less storage in both milk and fat of animals.

Research is conducted at Kerrville, Texas, by ENT and ADP in cooperation with Texas and Oklahoma Agricultural Experiment Stations, industrial concerns and livestock growers. At Beltsville, Maryland, investigations are carried out jointly by ENT and DH.

Development of methods of analysis of residues in animal fat: In cooperation with industrial concerns good progress has been made on developing sensitive and reliable methods for detection of insecticidal residues in meat and milk. New methods have been developed for determining malathion, perthane, and strobane in milk.

Insecticidal residues in animal fat and milk resulting from spraying animals: Yearling cattle sprayed 12 times with 0.5 percent strobane at 2-week intervals averaged 5.9 ppm strobane in the fat after the last spraying, which is less than with some other chlorinated hydrocarbon insecticides. One Jersey cow sprayed twice with 0.5 percent strobane emulsion excreted 0.61 ppm of the insecticide in milk one day after spraying; the residue decreased to zero 21 days later.

No detectable amounts of malathion were found in the fat of cattle sprayed at weekly intervals for 16 weeks with 0.5 percent of the insecticide. No off-flavor could be detected by HN of cuts of meat from two of the sprayed animals. When dairy cows were sprayed with 0.5 percent and 1.0 percent malathion less than 0.64 ppm showed up in the milk 5 hours after spraying. Only traces of the insecticide were found one day after spraying and none thereafter.

Milk samples from cows sprayed twice at 3-week intervals with 0.5 percent of perthane emulsion showed 0 to 0.39 ppm of the insecticide secreted. Milk samples from cows sprayed daily for 21 days with 1 ounce of 0.5 percent perthane oil spray ranged from 0 to 0.18 ppm.

Insecticide residues in animal fat and milk resulting from consumption of treated forage: Corn plants sprayed with 1.5 pound of DDT for European corn borer control in Iowa late in June contained 23.3 ppm of DDT residue in October. Steers pastured on the stover until December accumulated an average of 5 ppm of DDT in the loin fat which dropped to less than 0.1 ppm in three months after the animals were removed from the DDT-contaminated stover.

In Montana, beef cattle feeding on range vegetation sprayed with 0.75 ounce of dieldrin per acre for grasshopper control had an average dieldrin residue in the omental fat of 2.7 ppm one week after feeding, and 1.7 ppm after feeding on treated rangeland 8 weeks followed by feeding on untreated pasture 2 weeks. Four weeks later (6 weeks after removal of the cattle from the treated area) the residue dropped to 0.9

ppm. When the whole carcass was considered (assuming all residues are concentrated in the fat and allowing 20 percent of the total weight of the carcass as fat), the dieldrin residues exceeded 0.1 ppm even six weeks after the animals had been removed from treated vegetation. The residue analyses were made by Shell Chemical Corporation.

Dairy cows fed alfalfa hay daily that had been sprayed with 3.5 ounces of dieldrin per acre had a range of 0.7 to 1 ppm of dieldrin in the milk during a 54-day feeding period. Cows fed hay daily that had been sprayed with 7 ounces of dieldrin per acre (2.9 ppm of dieldrin in hay) had a range of 1.4 to 2.2 ppm of dieldrin in the milk during a 52-day feeding period.

Plans for future work on insecticidal residues (animal products): ENT
Plans are to expand the investigations because of the importance of ascertaining the precise levels of insecticidal residues in milk and meat. Such determinations are required for an appraisal as to whether or not they are excessive from the viewpoint of human health. This evaluation is required before recommendations can be made to growers on the use of different insecticides for the control of pests on food crops. Many new and promising materials are available that will be tested wherever possible.

Publications:

"Excretion of heptachlor epoxide in the milk of dairy cows fed heptachlor-sprayed forage and technical heptachlor." R. E. Ely, L. A. More, P. E. Hubanks, R. H. Carter, and F. W. Poos. Jour. Dairy Sci. 38:669-672. 1955.

"Excretion of endrin in the milk of dairy cows fed endrin-treated forage and technical endrin." R. E. Ely, L. A. More, P. E. Hubanks, R. H. Carter, and F. W. Poos. Jour. Dairy Sci. (In press).

"Excretion of dieldrin in milk from cows grazed in endrin-treated pasture." B. A. App, R. H. Carter, Ray E. Ely. Jour. Econ. Ent. (in press).

"Excretion of dieldrin in the milk of cows fed dieldrin-sprayed forage and technical dieldrin." R. E. Ely, L.A. More, R. H. Carter, P. E. Hubanks, and F. W. Poos. Jour. Dairy Science. 37:1461-1465. 1954.

"Dieldrin, aldrin and lindane - systemic insecticides - against livestock pests. W. S. McGregor, R. D. Radeleff, H. V. Claborn, and R. C. Bushland. Agr. Chem. 10(1): 34-36, 123. 1955.

1. Effects of Pesticides on Food Quality and Flavor (Continued)

Summary by HN

HN;ENT;HC

Relationships between insecticide treatment and flavor of products as they reach the consumer present continuing problems in the development and use of effective chemicals for the control of insects attacking foods during production, processing, or storage. During the year flavor evaluations were made on a number of vegetables and on samples of beef from controlled field experiments designed to test specific treatments for insect control, phytotoxicity, or both.

Current findings tend to substantiate the general results of past investigations i.e., of the insecticides in current use, the greatest flavor problems are presented by the benzene hexachloride (BHC) insecticides. Results continue to demonstrate the likelihood of flavor defects in root crops grown in soils treated with BHC or contaminated with residues from foliage applications or carried over in the soil from treatments applied in preceding years. This year carrots and turnips were found to be off-flavored when grown without direct treatment with insecticide, but in soils which carried residues of technical BHC from heavy applications to a series of preceding crops. Turnips were also off-flavored when the preceding crops were treated with lindane.

In addition to flavor defects in root crops from direct soil exposure to residues of BHC insecticides, definite off-flavors were observed in snap beans grown in soils carrying residues of technical BHC or lindane from a series of heavy applications of these insecticides to preceding crops. These findings indicate that the insecticide or associated flavor principle can be absorbed from the soil and translocated to above ground portions of the plant.

In tests of other products treated with BHC insecticides, flavor of winter squash and of grapes was normal following treatments with lindane during growth. Among three varieties of summer squash (scallop, yellow straightneck, and zucchini) produced on plants dusted with lindane, there was some, but not conclusive evidence of off-flavor in the scallop and zucchini varieties.

Studies to date have provided little or no evidence of significant off-flavors in foods tested following direct treatment with or exposure to soil residues of insecticides other than BHC. Snap beans were not off-flavored when grown in soils carrying residues of chlordane, dieldrin, methoxchlor, toxaphene, aldrin, TDE, or DDT from heavy applications of these insecticides to a series of preceding crops, and carrots were normally flavored when produced in soils similarly contaminated with residues of dilan or isodrin.

Selected cuts of beef from animals sprayed with malathion insecticides were normal in flavor.

Plans: Evaluations of the effects of pesticides on food flavor will be continued by HN as requested by other ARS agencies.

2. Yields of Food in Institutional Preparation

HN

In continuation of work reported last year, data on yields and losses of 162 foods as purchased and prepared for institutional use under actual feeding conditions were collected at four institutions, under contract at Drexel Institute of Technology, Yale University, St. Luke's Hospital in New York, and Iowa State College. These figures, together with data obtained from studies at Beltsville, Maryland, and from the literature provided a basis for the preparation of a "Food Buying Guide for Type A School Lunches" for distribution by AMS.

Yield data for frozen fruits and vegetables for inclusion in the food buying guide, as well as needed thawing and cooking information for the publication "Recipes for Type A School Lunches," were obtained through laboratory research at Beltsville. Three brands each of 26 frozen fruits and vegetables, packed in containers ranging in size from 2-1/2 to 30 pounds, were thawed at room temperature and at refrigerator temperature. Vegetables were cooked by boiling on top of the range and by steaming in a compartment steamer at 5 pounds pressure. Fruits were prepared by heating on top of the range and in a steam jacketed kettle. The yields of cooked frozen vegetables ranged from 64 to 120 percent for the different kinds of frozen vegetables studied. Frozen asparagus, kale, and turnip greens had the lowest yields ranging from 64 to 81 percent; frozen blackeye peas, lima beans, and succotash had the highest yields ranging from 98 to 120 percent. Yields for other frozen vegetables such as green beans, collard greens, broccoli, cauliflower, corn, okra, peas, peas and carrots, squash and mixed vegetables ranged from 85 to 99 percent. Method of cooking by steaming or boiling seemed to make no consistent difference in the yield. Frozen fruits which were heated for 1 minute to prevent darkening usually had higher yields when they were heated by boiling on top of the range than in a steam jacketed kettle.

Plans: Accumulated yield data from institution and laboratory research will be prepared for publication. Research should be continued as opportunity permits to obtain data on the variation in yields and losses from food of different market qualities and from common methods of handling food during preparation in home and institutional kitchens.

3. Adequacy of Cooking Procedures for the Destruction of Salmonella

HN

In developing recipes for home and institutional feeding, safety is a factor to be considered when the recipe includes foods that may be carriers of bacteria capable of causing food poisoning or infection. To provide data for estimating the extent to which the heat applied in cooking a variety of types of food will be adequate to destroy infectious or food poisoning organisms, determinations

were made of heat penetration during the cooking of 26 family-size and 11 institutional-size food preparations. The resulting data were evaluated by applying procedures developed in studies of the processing of canned foods, i.e., when the heat resistance of an organism to be destroyed is known, this information can be combined with data on temperatures attained within a food preparation during cooking to estimate whether the total heat applied is sufficient to destroy the organism in question. Because Salmonella bacteria are responsible for frequent outbreaks of food infection and a variety of foods, including meats, poultry, dried and frozen eggs, milk, and other dairy products, have been implicated as carriers of infection, the heat penetration data were interpreted in terms of expected destruction of these organisms. The results of thermal-death-time studies on Salmonella bacteria carried out in the WU and the Quartermaster Food and Container Institute were used as a basis for evaluating the heat penetration data. Bacteriological recovery tests, made on selected foods after inoculating with cultures of Salmonella bacteria and cooking, showed that lethal values estimated from heat penetration data were sufficiently accurate for predicting destruction or survival of these bacteria during cooking.

With most of the food preparations studied, estimations of lethalties, based on heat penetration alone, indicated that the probability of Salmonella bacteria surviving during cooking would be negligible. Breads, cakes, and cookies were among the foods that were sufficiently heated during baking to be considered free of viable Salmonella. Other food preparations which were adequately heated were veal patties, meat potatoburgers, french toast, cheese meat loaf, liver loaf, and salmon loaf; corn fondue, egg souffle, spoon bread, corn or carrot pudding, raisin bread or rice pudding, macaroni and cheese casserole; cooked salad dressing; baked custard, pumpkin pie, baked prune whip, and meringue shells. On the other hand, the heat applied in customary baking procedures for chocolate meringue pie, cheese bean loaf, scalloped egg and fish, and spanish egg and noodles was inadequate to insure the total destruction of Salmonella bacteria if present in the ingredients. Results of this study show that, when periods of 20 minutes or more are required to reach a maximum internal temperature during the oven baking of food preparations, and the slowest heating portions reach a temperature of 160° F. or higher, the heat applied will be adequate to assure destruction of the most heat resistant types of Salmonella bacteria. The data developed in this study will be applicable also to estimating the probability of destruction during cooking of other food poisoning or infectious organisms as well as of biological warfare agents.

Plans: This work has been discontinued.

4. Flavor and Cooking Quality of Eggs

HN

Eggs of different candled qualities resulted from holding newly laid eggs for definite periods of time under various temperature and humidity conditions which previously had been found to be common practice. As commonly observed, a change from one candled quality

to another is accompanied by thinning of albumen, flattening of yolk, development of off-flavors, losses in weight, and increases in pH of albumen and yolk; also, to a lesser extent, by decreases in thickening and leavening powers. At all temperatures of storage noticeable thinning of albumen and development of off-flavors occurred earlier than decline of functional performance.

There was considerable over-lapping of values for physical, functional, and flavor properties of eggs obtained for adjacent classes of AA, A, B, and C quality eggs. Statistically significant correlations up to 0.81 were obtained between candled quality and albumen index, yolk index, Van Wagenen albumen score, and Haugh unit. Correlations up to 0.80 were obtained between candled quality and angel food cake quality as measured by volume and panel scores for texture, tenderness, and acceptability; poached egg quality as measured by cooked albumen index and panel flavor scores; and panel flavor scores of egg cooked in the shell. However, there was little or no relationship between candled quality of eggs and the firmness of baked custards as measured by penetrometer readings or height of the baked custard.

Plans: Significant findings from the three institutions participating in this coordinated research are being integrated into a chart-book form of presentation for use by teacher-leader groups of home economists, producers and marketing research workers.

Publications:

"Candled Quality as a Measure of Functional Properties of Eggs." R. W. Parsons. Poultry Processing and Marketing 61(3): 13, 20. March 1955. (Contract with Purdue Agricultural Expt. Sta.)

"The Flavor of Your Eggs--How Good Is It?" B. A. McLaren and W. J. Stadelman. Poultry Processing and Marketing, Vol. 61(2): 20-21, 34, 36, February 1955. (Contract with Washington Agr. Expt. Sta.)

"Shell Eggs - Quality and Properties as Affected by Temperature and Length of Storage. R. Jordan, A. T. Barr, and M. L. Wilson. Purdue Agr. Expt. Sta. Bulletin 612, 59 pp. Oct. 1954. (Contract with Purdue Expt. Sta.)

"A Comparison of Several Methods for Evaluation of Quality in Eggs." V. Harns, E. A. Sauter, B. A. McLaren and W. J. Stadelman. Poultry Science, Vol. 33: 1022-1028, Sept. 1954. (Contract with Washington Agricultural Experiment Station)

"Relationship Among Physical, Functional, and Flavor Properties of Eggs." B. A. McLaren and W. J. Stadelman. Washington Agr. Expt. Sta. Tech. Bul. 14, 31 pp., Sept. 1954. (Contract with Washington Agr. Expt. Sta.)

"The Effect of Season, Age, and Storage Conditions on the Flavor of Eggs and Products Made Using Eggs." V. Harns, E. A. Sauter, B. A. McLaren and W. J. Stadelman. Poultry Science 33(5):992-997, Sept. 1954. (Contract with Washington Agr. Expt. Sta.)

"Seasonal Variation in Quality of Eggs as Measured by Physical and Functional Properties." E. A. Sauter, V. Harns, W. J. Stadelman and B. A. McLaren. Poultry Science, Vol. 33: 519-524, May 1954. (Contract with Washington Agr. Expt. Sta.)

5. Cooking Methods for Grass-Fed, Cow, and Other Beef of Low Market Grades

HN

Results of contract research at the University of Chicago on methods of cooking Commercial and Prime grades of beef round, and at the University of Georgia on methods of cooking three muscles of the rounds of grass-fed animals of low grade were published during the year. Reports of contract research at New York State College of Home Economics, Michigan State College, and Texas Agricultural Experiment Station have been approved for publication. This research was part of a comprehensive investigation basic to the development of improved household cooking methods for grass-fed, cow, and other beef of low grades which has been carried out under contract or cooperatively at seven locations (New York, Michigan, Iowa, Kansas, Texas, Georgia, and Chicago, Illinois).

In the Chicago study, fourteen cooking methods were compared with a standard braising method for cooking low grade beef. Comparable cuts 1-1/2 inches thick had slightly higher palatability scores after roasting in a 250° or 300° F. oven than after standard braising. Cuts roasted at 250° F. had lower shear values and were judged more tender by a taste-panel than standard-braised cuts, but meat roasted at 300° F. was judged superior in juiciness to beef roasted at the lower temperature. In general, however, pressure-braised cuts had lower tenderness and juiciness scores than standard-braised cuts. Palatability and shear values of meat braised without added water were similar to those for standard-braised meat. Weight losses during cooking were lower for cuts roasted at 300° but greater for cuts roasted at 250° F. and for some pressure-braised cuts than for standard-braised beef. Cuts roasted at 250° F. contained less collagen and less moisture than corresponding cuts roasted at 300° F. or braised by the standard method. Soaking in an acid solution for 48 hours in the refrigerator or braising in an acid solution failed to increase tenderness as measured by pounds pressure required to shear the meat. Cuts treated with commercially prepared enzyme tenderizer and cuts treated with papain were more tender than standard-braised cuts as shown both by shear readings and by panel scores, but more of the enzyme-treated cuts had lower juiciness scores. Pounding, but not scoring, before braising increased the tenderness of beef round.

In the Georgia study, a comparison was made of the effects of roasting, broiling, and range- or oven-braising on the quality and nutritive value of selected muscles of the rounds of eight grass-fed animals of low grade. Cuts 1-1/2 inches thick cooked by moist heat

lost less weight than those cooked by dry heat, whereas the opposite effect was true for the 3-inch cuts. For all cuts the percent of cooking loss attributed to drippings was greater in moist heat than in dry heat methods and greater in oven-braised than in range-braised cuts. Steaks cooked to an internal temperature of 160° F. were significantly juicier than those cooked to 176° F. Corresponding cuts cooked by dry and moist methods revealed no significant differences in judges' scores for juiciness or tenderness but cuts cooked by dry heat were found to be significantly better in flavor. Thiamine and riboflavin content of both raw and cooked samples varied significantly between animals, and riboflavin content was significantly different in the three muscles the semimembranosus, semitendinosus, and biceps femoris studied. Under the conditions of this experiment, differences in percentages of thiamine and riboflavin retained in the meat during cooking were not significant between cuts roasted or broiled (dry heat method) and those braised (moist heat method).

At Michigan State College, 1-inch steaks cut from the principal muscles of the rounds of six commercial grade cows were compared for the effect of method of cooking, time of storage before cooking, differences between muscles, and differences between beef- and dairy-type cows.

In this series, dry heat cooking in a 450° F. oven was superior to braising as a method of cooking commercial grade beef, both for palatability and for yield. Storage of the steaks at 32° -34° F. did not increase the tenderness of the beef, while aroma, flavor, and juiciness scores decreased with increasing storage from 7 to 21 days. Of the four large muscles of the round, the adductor was the most palatable, the biceps femoris the least. Differences within a group of animals, whether dairy or beef type, were generally greater than differences between the two types of animals.

At Cornell University information was obtained on top and bottom round and chuck cuts from six dairy cows of Good Grade and below. Corresponding cuts from six steers of Choice grade were used as a standard for comparison. The study reports the effects on the edible quality and the nutritive value of the cooking of unfrozen, "refrigerator-thawed" or "cooking-thawed" cuts by oven- and pressure saucepan-braising.

In this series pressure-braising was found to be preferable to oven-braising for maximum palatability of top and bottom round and chuck from low grade cow beef. On the other hand, the Choice grade steer beef was not made significantly more tender by pressure-braising than by oven-braising. For all grades, oven-braising was better than or at least as good as pressure-braising in terms of thiamin retention; whereas, pressure-braising was better than or at least as good as oven-braising in terms of riboflavin retention.

At the Texas Agricultural Experiment Station, the tasting panel found well-done broiled steaks more juicy than braised steaks, and little if any difference in juiciness between well-done oven

roasts, from either steer beef of Utility grade off grass pasture or of Choice grade from the feed-lot. Bottom round steaks of both grades were more tender when braised than when broiled. Choice grade loin steaks were about equally tender cooked by broiling and by braising but those from Utility grade were more tender when braised. Of the roasts from rib, top and bottom round, and chuck, bottom round was the only cut in which braised roasts were significantly more tender than the oven roasts.

Thiamine and niacin retentions were higher in broiled steaks than in braised steaks. Braised steaks together with broth, however, contained as much thiamine and more niacin than the broiled steaks. The meat of the oven roasts contained somewhat less thiamine but more niacin than the meat of braised roasts without broth. It was only when the retention values were combined for meat and broth of braised roasts that the retention of niacin was greater for the oven roasts. No evidence was obtained that the Choice and Utility grade beef differed in either content or retention of thiamine and niacin.

Plans: Data from the various locations are being integrated for a final publication.

Publications:

"The effect of different methods of cooking beef round of Commercial and Prime grades. I. Palatability and shear values." R. M. Griswold. (Contract research with University of Chicago, sponsored by HN.) Food Res. 20(2): 160-170. March-April 1955.

"The effect of different methods of cooking beef round of Commercial and Prime grades. II. Collagen, fat, and nitrogen content." R. M. Griswold. (Contract research with University of Chicago, sponsored by HN.) Food Res. 20(2): 171-179. March-April 1955.

"Effects of cooking methods on low grade beef." M. P. Hood, D. W. Thompson, and L. Mirone. (Contract research with University of Georgia, sponsored by HN.) Georgia Agr. Expt. Sta. Bul. N. S. 4, 20 pp. February 1955.

6. French-Frying Quality of Potatoes

HN;BS

Studies of the French-frying quality of potatoes as influenced by specific gravity of tubers, storage conditions, and cooking methods, investigated in cooperation with BS, have been completed and a technical bulletin is in press. Results showed that crispness, mealiness, lack-of-oiliness, and flavor scores for French-fried potatoes were higher as tubers of higher specific gravity were used. The percentage of dry matter in the raw and fried samples and yield of French-fries tended to increase whereas oil content of fried samples generally decreased with increase in specific gravity of raw tubers.

Potatoes transferred from 40° F. storage after 5 months showed a progressive decrease in reducing sugar content during holding at 70° F. for 1, 2, or 3 weeks. The French fries made from these tubers were more mealy, less oily, and had better color and flavor than those

made from tubers immediately after removal from 40° F. storage. A comparison of desugaring for 2 weeks at temperatures of 70° and 80° F. following 5 months storage at 40° F. indicated significantly higher scores for color and flavor at 80° F. in some lots of potatoes.

Holding partially fried potatoes at room or refrigerator temperature no longer than 2½ hours between first and second stage frying had most effect on the palatability characteristics of flavor and tenderness. Shear force values were consistently higher (i.e. potatoes were less tender) for samples that were held than for those cooked without any appreciable time lapse between the two stages of frying.

Except for a slight decrease in tenderness and less uniformity of browning, frozen parfried potatoes heated in 500° F. oven for 10 minutes, or in a 500° F. oven for 5 minutes followed by 3 minutes in a broiler, compared favorably with those heated in deep fat. Heating in a broiler for 5 minutes was the least satisfactory of the methods tried. No significant difference in palatability were found due to thawing or not thawing frozen parfried potatoes before cooking by the oven, oven-broiler, or broiler methods. Potatoes finished off in the oven were about 15 percent lower in fat content than if final cooking was in deep fat.

French-fried potatoes from parfries made at the time the tubers were harvested and held 2 to 9 months in freezer storage were comparable in palatability to freshly prepared French fries. Those made from tubers stored 2 or 4 months at 50° F. then parfried and held in freezer storage 5 to 7 months were somewhat lower in quality. All frozen samples, whether prepared at harvest or after tuber storage for 2 or 4 months, made French-fried potatoes of satisfactory quality except for mealiness in samples from tubers stored for 4 months.

Plans: This work has been completed with the preparation of a USDA Bulletin.

Publications:

"Cooking quality and compositional factors of potatoes of different varieties from several commercial locations." P. H. Heinze, M. E. Kirkpatrick, and E. F. Dochterman. Tech. Bul. 1106, March 1955. (Cooperative with AMS)

III. HUMAN NUTRITION

A. Progress on Work Under Way

1. Fatty Acid Requirements

HN

Research to determine fatty acid requirements has continued under contract with the University of Texas Medical Branch, with particular emphasis on the influence of diet on the nutritionally important unsaturated fatty acids in blood serum. In view of the findings with experimental animals that the blood serum level of 2, 3, and 4 double-bond fatty acids reflects dietary history, nutritional status, and essentiality of certain unsaturated fatty acids, investigations were undertaken to determine the influence of different dietary levels of one essential fatty acid (linoleic) on the unsaturated fatty acid content of the blood serum of infants. With normal infants under one year of age, a definite relationship was demonstrated between the amount of linoleic acid in the series of milk formulas and the level of unsaturated fatty acids in their blood serum. When the infants received a low fat milk mixture supplying one percent of the calories as fat and 0.04 percent of the calories as linoleic acid, the serum levels of di- and tetraenoic acids (linoleic and arachidonic) were very low while a relatively high level was observed for trienoic acid, and acid normally present in serum in relatively small amounts. When the low fat milk was replaced by an evaporated milk mixture supplying 38 percent of the calories as fat and 0.9 percent of the calories as linoleic acid, the serum levels of di- and tetraenoic acids increased and that of the trienoic acids decreased. With milk mixtures in which fats supplied 33 percent of the calories and linoleic acid 2, 3 and 5 percent of the calories, changes in the unsaturated fatty acids of the serum were of still greater magnitude and in the same direction as were those observed for the evaporated milk mixture. At no time, however, did the serum levels for the di- and tetraenoic acids of infants receiving the formulae reach those found in infants fed breast milk in which linoleic acid accounts for about 4 percent of the calories. No clinical abnormalities were observed within the one-to-four-week period during which infants were fed a low fat milk diet but the changes in the fatty acids in the blood serum were similar to those observed with dogs on a low fat diet which, after an extended period of time, resulted in typical signs of fat deficiency.

Plans: The investigations with infants will be continued, using diets containing other amounts of fat and fatty acids.

Publications:

"Effect of Dietary Fat on Unsaturated Fatty Acids of Serum of Infants." Arild E. Hansen, Hilda F. Wiese, Marjorie Lawlis, Doris J. D. Adam, and Marjorie A. Baughan. Federation Proceedings 14, 436, March 1955.

"Fat in Diet of Infants in Relation to Caloric Consumption, Growth and Serum Levels for Specific Fatty Acids." Arild E. Hansen, Hilda F. Wiese, Marjorie Lawlis, Doris J. D. Adam, Armond Goldman and Marjorie Baughan. Published in the Proceedings of the American Pediatric Society.

"Influence of Fat in Diet on Distribution of Unsaturated Fatty Acids in Serum of Dogs." Hilda F. Wiese, Marjorie A. Baughan and Arild E. Hansen. Federation Proceedings 14, 453, March 1955.

2. Amino Acid Requirements

HN

Coordinated research at three institutions under contract are providing the first metabolic data indicating the probable amino acid requirements of women, as measured by the amount of various pure amino acids required to maintain balance between nitrogen intake and output. Values have been obtained for threonine, valine, tryptophane, phenylalanine, lysine, and methionine.

Plans: Data on requirements and on values in foods are being evaluated and prepared for publication.

Publications:

"The Amino Acid Requirement of Young Women. IV. Phenylalanine." R. M. Leverton, N. Johnson, J. Ellison, M. Skellenger, D. Geschwender, and F. Schmidt. Federation Proceedings 14, 441, March 1955.

"Methionine and Lysine Requirements of Mature Women." E. M. Jones, C. A. Baumann, and M. S. Reynolds. Federation Proceedings 14, 438, March 1955.

3. Influence of Carbohydrates on Amino Acid Requirements

HN

Research on the influence of dietary carbohydrate on amino acid requirements in adult rats is contributing important basic information for planning diets adequate in protein. These investigations have shown that, with restricted protein intake, corn dextrin and the starches of corn, rice and wheat, tend to lessen the amount of amino acids required to maintain nitrogen balance, and also lessen the amount of liver fat deposited as compared to diets containing sucrose in place of starch. All starches are not equally effective in reducing the amino acid requirements, rice starch being most effective and potato starch least among those studied to date.

Plans: These investigations will be extended to include other carbohydrates and to study the possible influence of the levels of other sources of nitrogen.

4. B-Vitamin Requirements

HN

One phase of research to determine the requirement of B-vitamins for normal individuals of different ages has been completed through studies of the thiamine and riboflavin requirements of adolescent

boys. Investigations under contract using eight healthy boys 14-17 years of age were carried out during a 69-day test period on graded levels of intake. Statistical analysis of the data resulted in an estimated daily requirement for this age group of 1.36 mg. of thiamine or 0.38 mg. per 1,000 calories, estimates which agree well with several published values for adults. For riboflavin, analyses indicate a requirement of about 0.30 to 0.35 mg. per kilogram of body weight as compared to the National Research Council allowance of 0.25 mg. per kilogram for boys of this age.

Plans: This phase of the work has been completed and reports are in preparation.

Publication:

"Estimation of Thiamine Allowances for Adolescent Boys." Janice M. Smith, Shih-Dzung Chen, M. H. Bert, and Edna Dick. Federation Proceedings 14, 450, March 1955.

5. Balance Among Nutrients in Diets

HN

Investigations have continued to determine the nature of the balance among nutrients necessary to promote health in middle-aged and old animals and to prolong life. Varying degrees of untoward effects resulted when a share (25 percent) of a semi-purified diet adequate for growth and health was replaced by one of a series of high-fat, high-protein foods. Evidence has been obtained that the metabolic effects are due to imbalance among nutrients created in the experimental rations fed.

Investigations to evaluate the role of specific nutrients are under way but are not sufficiently advanced to permit drawing definite conclusions. Factors under study include the amount and kind of fat and high levels of individual proteins and the B-vitamins, pyridoxine, B₁₂ and choline. The effects of diet are being measured by histological examination of selected tissues, the chemical composition of kidneys and livers (fat, protein, ash, and moisture) and cholesterol content of blood.

Within the past year, electrophoretic analysis of the sera of several animals receiving 75 percent of the basal diet and 25 percent dried cooked eggs has been made which disclosed an unusual pattern. When compared with normal rat sera, the amount of serum albumin and of beta globulin was relatively low and of alpha globulin high. Furthermore there were present three or more unique components moving faster than albumin. The pattern observed resembles that found with hyperlipemic individuals injected with heparin and suggests that lipase activity of the clearing factor may be involved. Since, in general, blood serum proteins have been found to remain fairly constant even with marked differences in diet, the finding that the electrophoretic pattern of the serum protein of the rat may be changed by diet alone is noteworthy. The results are amenable to several possible explanations and further research is necessary before definite conclusions

can be drawn as to the significance of these findings.

Plans: Studies of the effect of adding either single nutrients or combinations of nutrients to diets responsible for premature degenerative changes in the tissues of the animals will be continued, focussing upon dietary factors which seem significant in view of the findings on the four commodities used in the first series of experiments.

Electrophoretic investigations will be continued and will include determinations of the electrophoretic pattern of the serum protein with other combinations of foods and nutrients. Statistical analysis of the completed data will be undertaken in preparation for publications reporting the results of the first series of experiments.

Publication:

"Alteration of Rats' Serum Protein Produced by Diet." Elizabeth C. Callison and Murray Fisher. Federation Proceedings 14, 429, March 1955.

6. Heights and Weights of Children

HN

As one of a series of basic reference tables on physiological criteria of nutritional status which are being developed, data, published and unpublished, on average heights and weights of children in the United States are being classified by sex, age (single years from 2 to 20), region and state of origin, and dates of measurements. Data for commonly used standards will also be included as well as an annotated list of over 150 references. Various research workers throughout the country have cooperated in providing detailed unpublished data for this compilation.

Plans:

Tables for height-weight increments related to state of maturity of children and height-weight caloric intake data of children and adults will be summarized.

7. Diets and Nutritional State of Individuals

HN

Substantial progress has been made in the publication of results of cooperative studies with the North Central and Western Regions of food intake and nutritional status. During the past year, 40 papers have been published in scientific journals and bulletins, and others are ready for publication. Dietary findings of the various surveys often backed up by corresponding biochemical values, show that diets contain less than desirable amounts of calcium, vitamins A and C, and in some places, less thiamine. Diets of teenage girls tend to be lower in most nutrients than those of boys, adolescents relatively lower than younger children. Facts such as these help to guide educational and food distribution programs for improving human nutrition.

Plans: Additional publications reporting the findings of these cooperative investigations will be prepared with particular emphasis on regional reports.

Publications:

"The Nutritional Status of Papago Indian Children." M. G. Vavich, A. R. Kemmerer and J.S. Hirsch. Journal of Nutrition 54:121-132, 1954.

"Nutritional Status of the Aging. I. Hematology of 577 Normal Men and Women Over 50 Years of Age." H. L. Gillum, and A. F. Morgan. Journal of Nutrition 55: 265-288, 1955.

"Nutritional Status of the Aging. II. Blood Glucose Levels." H. L. Gillum, A. F. Morgan and R. I. Williams. Journal of Nutrition 55: 289-303, 1955.

"Nutritional Status of the Aging. III. Serum Ascorbic Acid and Intake." A. F. Morgan, H. L. Gillum and R. I. Williams. Jour. Nutrition 55: 431-448, 1955.

"Nutritional Status of the Aging. IV. Serum Cholesterol and Diet." A. F. Morgan, H. L. Gillum, and D. Jerome. Jour. Nutrition 55: 449-468, 1955.

"Nutritional Status of the Aging. V. Vitamin A and Carotene." H. L. Gillum, A. F. Morgan and F. Sailor. Jour. Nutrition 55: 655-670, 1955.

"Nutritional Status of the Aging. VI. Serum Protein: Blood Non-Protein Nitrogen, Uric Acid, and Creatinine." A. F. Morgan, M. Murai, and H. L. Gillum. Jour. Nutrition 55:671-685, 1955.

"Dental Caries Prevalence in Children 15 and 16 Years of Age in Three Idaho Communities." K. O. Porter and E. Woods. J. Dental Research 33: 542:551, 1954.

"Nutritional Status of Adolescent Idaho Children. I. An Evaluation of Seven-Day Dietary Records." K. P. Warnick, S. V. Bring and E. Woods. Jour. Am. Dietet. Assoc. 31:486-490, 1955.

"Children With and Without Rheumatic Fever. I. Nutrient Intake, Physique, and Growth." E. B. Wilcox, and L. S. Galloway. Am. Dietet. Assoc. Jour. 30: 345-350, 1954.

"Children With and Without Rheumatic Fever. II. Food Habits." E. B. Wilcox and L. S. Galloway. Am. Dietet. Assoc. Jour. 30: 453-457, 1954.

"Children With and Without Rheumatic Fever. III. Blood Serum Vitamins." E. B. Wilcox, L. S. Galloway, P. Wood, and F. L. Magelson. Am. Dietet. Assoc. Jour. 30: 1231-1238, 1954.

"Dental Studies of Montana College Freshmen & Adolescents." L. M. Odland, L. Page and H. L. Mayfield. Mont. Expt.Sta. Tech. Bul. 506, Apr. 1955.

"Children With and Without Rheumatic Fever. IV. Hemoglobin, Packed Red Cells, Red and White Cell Count, Sedimentation Rate, Blood Glucose, Serum Iron and Copper. E. B. Wilcox, F. L. Mangelson, L. S. Galloway, and P. Wood. Am. Dietet. Assoc. Jour. 31:45-51, 1955.

"Weights of Foods Eaten Per Meal by 242 Women 30 to 92 Years of Age." R. M. Beegle, P. H. Roberts, N. Howard and others. Michigan Expt. Sta. Tech. Bul. 244, 32 pp., 1954.

"The Relation of Age to Fat Absorption in Adult Women Together with Observations on Concentration of Serum Cholesterol." P. Garcia, C. Roderuck, and P. Swanson. Jour. Nutrition 55: 601-609, 1955.

"Blood Values of Women: Cholesterol." P. Swanson, R. Leverton, M.S. Gram, and others. Jour. Gerontology 10:41-47, 1955.

"Iowa Women - Contributors to Science." E. Willis, P. Swanson, P. Mairs, and H. Roberts. Iowa Farm Sc. 9: No. 4, 8-10, Oct. 1954.

"Iowa Women - The Kinds of Food They Eat." E. Willis, P. Swanson, R. Angus, and A. Rohm. Iowa Farm Sc. 9: No. 5, 19-21, Nov. 1954.

"We've Counted the Calories in Your Diet." P. Mairs, E. Willis and P. Swanson. Iowa Farm Sc. 9: No. 6, 15-18, Dec. 1954.

"Do Iowa Women Eat Enough Protein?" P. Swanson, E. Willis, and P. Mairs. Iowa Farm Sc. 9: No. 8, 14-16, Feb. 1955.

"You Don't Outgrow Your Need for Calcium." P. Swanson and E. Willis. Iowa Farm Sc. 9: No. 9, 12-14, March 1955.

"Fruits and Vegetables, Keys to Vitamins A and C." E. Willis and P. Swanson. Iowa Farm Sc. 9: No. 10, 11-12, April 1955.

"Overweight...A Problem Among Iowa Women." P. Swanson, E. Willis and P. Mairs. Iowa Farm Sc. 9: No. 11, 18-20, May 1955.

"Let's Reduce Sensibly." P. Swanson, E. Willis. Iowa Farm Sc. 10: No. 1, 6-8, July 1955.

"Nutritive Value of the Diets of Iowa School Children." E. S. Eppright, V. D. Sidwell and P. P. Swanson. Jour. Nutrition 54: 371-388, 1954.

"Physical Measurements of Iowa School Children." E. S. Eppright and V. D. Sidwell. Jour. Nutrition 54: 543-556, 1954.

"Relationship of Estimated Nutrient Intakes of Iowa Children to Physical and Biochemical Measurements." E. S. Eppright, C. Roderuck, V. D. Sidwell and P. P. Swanson. Jour. Nutrition 54: 557-570, 1954.

"Distribution of Calories Among Certain Foods and Food Groups in the Diets of Iowa School Children." E. S. Eppright and P. P. Swanson. Am. Dietet. Assoc. Jour. 31: 144-148, 1955.

"Distribution of Nutrients Among Meals and Snacks of Iowa Children." E. S. Eppright and P. P. Swanson. Am. Dietet. Assoc. Jour. 31:256-260, 1955.

"Diet and Nutritional Status of Iowa School Children." E. S. Eppright and C. Roderuck. Am. Jour. Public Health 45: 464-471, 1955.

"Food Intake and Body Size of Iowa School Children." E. S. Eppright, V. D. Sidwell and E. Jebe. Published in Weight Control, Iowa State College Press, 1955.

"Food Intake and Body Weight of Older Women." P. Swanson et al. Pub. in Weight Control, Iowa State College Press, 1955.

8. Reference Diet for Human Nutrition Research

HN

An experimental diet which supplies the essential nutrients at moderate reference levels has been developed for use as a standard diet with uniform analytical procedures. This diet is composed of simple readily available foods and other components of fairly constant composition and is easily modified to alter the content of single nutrients. Investigations on the metabolic response of six subjects (young women) to this diet have been completed. The levels of 60 grams of protein, 700 milligrams of calcium, 1.0 grams phosphorus, 220 milligrams of magnesium, 0.7 milligram of thiamine, and 1.0 milligram of riboflavin seemed satisfactory levels.

Plans: These investigations will be extended to evaluate further the use of this diet as a reference diet and to establish the response of additional subjects in different geographic locations to the levels of intake in this diet.

Publications:

"A Standardized Diet for Metabolic Studies; Its Development and Application." In press as USDA Tech. Bul. No. 1126.

9. Other Research on Human Requirements and Availability of Nutrients .HN

Other investigations on which the Department is not yet ready to report include the following: Comparison of the energy expenditures of women of different age groups engaged in selected physical activities (contract, Teacher's College, Columbia University); metabolic response of 7-9-year-old girls to a controlled dietary regime (in cooperation with six stations in the Southern region); exploratory research on the availability to humans of the nutritionally important amino acids, protein and food energy in selected foods (contract, George Washington Carver Foundation).

IV. FOOD CONSUMPTION AND DIETARY LEVELS

A. Progress on Work Under Way

1. National Food Supply

a. Changes in the Supply and Use of Farm Commodities

SHR

Work on the master index of supply-utilization of both food and non-food farm commodities has been completed for the years 1924-54. A handbook with the statistics and full description of methodology, uses and limitations of the master index and its coordinated subindexes will be published this fall. This new tool will provide, for example, the means of analyzing the effects of changes in food consumption patterns on agricultural production and vice versa.

b. Trends in Food Consumption

SHR

The 1954 Supplement to Agriculture Handbook No. 62 "Consumption of Food in the United States, 1909-52" will be issued as a separate bulletin this fall. It will contain a complete set of tables for the original bulletin with revisions and data for 1953 and 1954.

Data on per capita food consumption were analyzed for a paper "Changing Food Patterns of the American People" printed in the July 1955 issue of the National Food Situation.

A related study completed this year is an analysis of changes in food expenditures, 1929-54. Material for a bulletin to be published this fall has been organized to answer the following questions: (1) How did total food expenditures change from 1929 to 1954? (2) How much of our income goes for food? (3) Why have we spent more for food? (4) What have increased food expenditures bought?

c. Marketing Studies Related to Economic Loss and Wastes

CC

During 1954-55 AMS continued its research on costs of marketing farm commodities. One of the important costs is economic loss and waste. Knowledge of the extent of such loss and waste is being gradually accumulated through detailed statistical studies of marketing of individual commodities from the time they leave the field and the farm until the consumer buys them in the retail store or as part of meals in eating places. For example, Marketing Research Report No. 75 An Economic Study of Rough Rice Storage in the Southern States, Published Nov. 1954, includes information on losses from physical deterioration in storage. Somewhat comparable information has been developed for a considerable range of products.

Eventually, the accumulated data can be used to improve the estimates of per capita food consumption by using more reliable factors for waste and loss between the farm and the consumer's sack of food.

But costs of doing a one-time large-scale survey are prohibitive in view of the limited value of a single survey for one period of time in a given year.

2. Household Food Consumption

a. 1955 Food Consumption Survey

HN-SHR

Collection of data has been completed for the cooperative 1955 Food Consumption Survey providing a nationwide sample of about 6,000 households during April, May, and June. The survey will provide information on the food consumed during a week, with reporting of the kinds and quantities of food in enough detail to serve the needs of home economists, nutritionists, and those concerned with marketing agricultural products. Reports will be prepared on food consumption of urban, rural nonfarm, and farm families classified by income and region. For the farm group, separate data on purchased and home-produced food will be provided. Calculations of the nutritive content of family food supplies will be made for each group of families and for individual families so that the proportions with diets that meet nutritional recommendations can be estimated.

Publication plans call for a preliminary report in late 1955 of data on total family food expenditures. By spring 1956, the first of the series of regional-urbanization reports on the details of household food consumption will be released, with the remainder of this series coming from the press as rapidly thereafter as possible. These reports will be similar to the first of the series of preliminary reports issued on the 1948 urban food consumption survey. The data on the nutritive value of household food supplies will follow as soon as these relatively time-consuming calculations can be completed.

Plans: Preparing the basic data from the food consumption survey for release, including estimates of the nutritive content of family food supplies, is expected to take the major portion of staff time assigned to this area of work for the next two years and only a limited amount of analytical work can be undertaken with existing staff. Present plans for such research include an analysis of changes in income-food-consumption relationships. The resulting data are used in projections of demand and therefore are important to agricultural policy, as well as in the development of educational programs by home economists.

b. Food Consumption of Rural Families

HN

Food expenditures, home production, and food preservation of rural families in the North Central region is the subject of the first report from the survey of 1,152 families in 1952. This report will be the basis for educational programs of teachers, nutritionists, and extension workers and for policy and program decisions of USDA administrators and others interested in levels of living of rural families.

Average food expenditures of farm families in this region amounted to almost \$750 in 1951, one-fourth of their average cash income (after deduction of income taxes). For those farm families that had less than \$2,000 cash income, expenditures on food took over half their incomes.

Home-produced food valued at retail prices added about \$600 to the average family's food. Much of this was meat and milk. As the total value of home-produced food increased, the purchase of food for home use decreased, but at a decreasing rate, apparently approaching an average minimum outlay for families of 3 or 4 persons of about \$500.

Nearly all of the farm families and 80 percent of the rural nonfarm families canned some food, about the same proportion as reported doing some canning in 1935-36, although the families canned somewhat less total food in 1951 than in the earlier periods. Most of the food canned was fruits and vegetables (including jellies and pickles).

Nearly three-fourths of the farm families and a third of the rural nonfarm had facilities for freezing food in 1951--a freezer in the home or a rented freezer locker. Most of the food frozen was meat--many families continuing to can fruits and vegetables even though they had freezing facilities. Few families canned meat and for the most part they were families without any facilities for freezing it.

Plans: The food consumption (with amounts consumed, purchased, and produced on the home farm reported in detail) and dietary levels of these families is the subject of another publication now being prepared.

c. Household Food Losses

HN

Quantitative information on the amounts of all foods issued to the kitchen and all refuse and edible foods discarded during the preparation and serving of meals was obtained in 4 institutions over a 2-week period during 1953-54. By calculation the losses of edible food were translated to an as-purchased basis and the proportions that the losses were of the original issues were obtained. The nutritive value of the food issued, discarded, and eaten was then calculated. Three of the institutions were large, from 90 to 800 persons. One institution, a children's home, was small, each cottage having only 15 residents. In the three large institutions the discards of edible food were large, about one-fifth to one-fourth of the total food issued in terms of pounds; in the small institution the loss was only 5 percent. All foods sustained some loss during the preparation and serving of food, but the foods lost in greatest proportion were leafy, green, and yellow vegetables, potatoes, sweetpotatoes; meat, poultry, fish, and dry beans, peas and nuts. Lost in smallest proportion were milk, cream, ice cream, cheese; and citrus fruit and tomatoes.

Accordingly, iron and niacin were the nutrients showing the highest losses; calcium and riboflavin, the smallest. In the larger institutions, the losses for the nutrients calculated ranged from 13 to 38 percent; in the smaller institution, 3 to 10 percent.

Plans: Consideration has been given to the food waste survey proposed and given high priority by the Food and Nutrition Research Advisory Committee at its meeting in 1954. The staff agrees with the Committee that the subject is important, but proposes that a large-scale survey be postponed until more work can be done to determine the best method. Attempts to get waste data in conjunction with food consumption surveys has given low estimates (about 1 percent for calories for urban families in 1948) as compared with experiments with weighed and classified records of kitchen and plate waste. However, records of the latter kind probably could not be obtained from a representative sample of the population--both because of the high cost and of the high refusal rate characteristic of detailed record keeping.

Publications:

HN

"Household Practices in the Use of Foods, Three Cities, 1953."
C. LeBovitz and F. Clark. AIB- (In press)

"Food Expenditures, Home Production and Food Preservation, Rural Families in the North Central Region, 1951-52." (Report I of Survey in 12 States) M. Orshansky, E. C. Blake, and M. A. Moss. AIB- (In press).

"Planning the Farm Family's Food" in Rural Family Living, March 1955.

"Home Production of Food" in Rural Family Living, Mar. 1955.

"Family Purchasing Practices" in Rural Family Living, July 1955.

"Pasteurization" in Rural Family Living, July 1955.

3. Diet Appraisal

a. Amino Acid Tables

HN

Tables of the amino acid content of foods are being developed, making use of data resulting in recent years from the application of suitable analytical methods. The tables in preparation of average values for 12 amino acids in important foods are urgently needed by the Department, nutritionists, and other groups concerned with the adequacy of the protein quality of food supplies, including the MRC's Committee on Amino Acids. These Tables of the amino acid content of foods, when completed, will permit a fairly good estimate of the amino acid content of the percapita food supply, of family diets, and of the food intake of individuals.

b. Food Refuse, Yields, and Nutritive Value

HN

One of the problems in estimating nutritive values of diets is that of knowing the average amount of refuse or inedible portion of individual foods as brought into the kitchen. Figures allowed for refuse greatly affect the appraisal of household and institutional diets made on the basis of food purchases.

During the year there was reviewed and integrated a very large volume of published and unpublished data for many kinds of food on refuse, at different stages in preparation.

Plans: The data compiled will be published in tables for many technical uses, including the preparation of the next revision of H.B. 8, Composition of Foods. This consolidation of data is an extension of efforts reported last year (page 21, 1954) to bring together data for use in deriving quantities to purchase for school feeding.

c. Basic Data for Food and Nutrition Programs

HN

Knowledge of nutritional requirements, and how they may be met by foods, needs to be applied more effectively in the many programs concerned with nutritional betterment. In response to a widely felt need, work has begun on assembling and interpreting basic nutrition facts for use by teachers, nutritionists, extension workers and others who are trying to promote effective use of foods for nutritional health. First emphasis has been given to the development of simplified material on the essentials of an adequate diet. Using data on nutritional needs, the composition of foods, the potential contribution of various food groups to the diet, a basic food guide has been developed with supplementary material to show how to attain flexibility in its application to different food supplies, food habits and for different groups of persons.

Plans: Before publication, the manuscript is to be submitted to interested groups for comments and for suggestions for popular presentation.

d. Facts for Consumer Education

HN

A publication on bread in the series on Facts for Consumer Education is now in press. This publication based on evaluation of data from many sources was designed as a basic reference and source material for those preparing material for educational programs. Contents include information on consumption, nutritive value, production and marketing practices, buying tips and care in the home.

Plans: Work is in progress on potatoes, the next in this Facts series.

e. Services to Nutrition Committees

HN

The Nutrition Programs Service continues to facilitate exchange of information on programs and coordinated efforts among Federal, State, and local agencies concerned with nutrition.

To the Interagency Committee on Nutrition Education and School Lunch (a committee representing Washington agencies with nutrition programs in the States) it provides secretariat services to help advance the goal of the Committee: to promote joint efforts among the several agencies who share responsibility for improving diets and nutritional well-being of people in homes, institutions, and schools, and at work. Besides assisting with monthly meetings of this Committee, the Programs Service this year made arrangements for two special meetings: one, an all-day conference on nutrition education with emphasis on adapting programs to cultural, socio-economic, educational, and other differences, and providing experiences in nutrition education for adults; the other, a half-day meeting with an outstanding anthropologist to consider the contributions of anthropology to nutrition education.

The Programs Service also continues to issue, in consultation with the Interagency Committee, the bi-monthly publication, The Nutrition Committee News; through this medium as well as by correspondence and occasional visits, it maintains liaison with 35 State and other county, city, and local nutrition committees. This publication provides exchange of information on nutrition education and school lunch activities and reports on research findings on the food and nutrition situation, summarizing and interpreting them for program use. (See publications.)

Publications:

HN

"Nutritional Review," National Food Situation, NFS-70, October 29, 1954.

"Energy Value of Foods -- basis and derivation." A. L. Merrill and B. K. Watt. AH No. 74, 105 pp. Mar. 1955.

"Food and Nutrition Services of Federal and Quasi-official Agencies of the United States." ARS 61-Nov. 1954.

"Bread--Facts for Consumer Education." I. H. Wolgamot and L. J. Fincher. Agr. Inf. Bul. 142 pp. (In press)

"Do You Get Enough Milk?" Home and Garden Bul. 47, 8 pp. May 1955.

"Nutrition Committee News" -- 6 issues:

July-August 1954 -- Extension Service Methods for Teaching Nutrition. (Copy prepared by the Federal Ext. Service.)

September-October 1954--Nutrition Along the Highways and Byways of the World.

November-December 1954--Improved Diets Benefit Children in Institutions.

January-February 1955--Nutrition Education in Public School Programs. (Copy prepared by the Office of Education, Department of Health, Education and Welfare).

March-April 1955--State and Local News Roundup.

May-June 1955--Preparing Classroom Teachers for Their Role in Nutrition Education.

4. Food Purchases and Preferences

a. Purchasing Practices of Non-Household Eating Establishments and in Food Industries

(1) Industrial Feeding Facilities

CC & MD

During the last decade, the number of industrial feeding facilities has increased to such an extent that they now represent an important market for food. Because this expansion took place so rapidly, little is known about the needs and buying practices of these food services. Therefore, this study has been planned to determine marketing practices and channels used by industrial feeding facilities in purchasing food. Data will be collected on where they buy, how they buy, how much and what kind of food they use, and to what extent they use commercially added services such as portioned-meat and pre-peeled potatoes.

Plans: The survey will be done under contract with a nongovernmental agency in either selected cities or a national sample of plants. A complete report of findings and the implications to marketing practices and channels will be published. Prior to this, findings related to selected commodity groups may be released in preliminary form.

(2) Use of Frozen Foods

CC

As a part of research on marketing trends for frozen foods, studies have been undertaken to determine frozen food marketing costs and practices by measuring the utilization and movement of food products through several of the major market outlets.

One of these studies was a survey of the use of frozen foods and their corresponding canned and fresh items by public

eating places. A sample of 480 restaurants and cafeterias reported their purchases during two 4-week periods in August and November 1954. Only restaurants with over five employees in cities with 50,000 population and over were included.

It was found that restaurants bought more of their foods in frozen form than the pattern for the whole market. The larger-sized restaurants and the ones serving the higher-priced meals used a larger proportion of fruits and vegetables in frozen form than the smaller restaurants and the ones serving the lower-priced meals. Turkey was used in the frozen form to a greater extent than chicken.

Preliminary reports have been completed as to the use of fruits by: (1) ice cream manufacturers; (2) preserve manufacturers; and (3) pie bakers. About 600 million pounds of fruit in all forms move through these outlets. Almost 80 percent of the fruits used in the ice cream industry, 46 percent in the manufacture of jams, preserves, and jellies, and about 42 percent of fruit usage by wholesale pie bakers were obtained in frozen form. Levels of future use of frozen fruits by these industries appear to be linked most closely to the rate of population growth, although lesser increases may be associated with rising per capita spendable incomes. The pattern of fruit use, by form -- fresh, frozen, and canned -- appears to be relatively stable.

Plans: Work completed -- reports in preparation.

Publications:

"The Use of Frozen Foods by Restaurants and Cafeterias." H. W. Bitting, March 1955. Paper presented at the Frozen Food Distributors' Convention, Chicago, Ill.

"Quantities of Fruits Used in the Manufacture of Jams, Jellies, and Preserves." R. B. Reese, March 1955. Mimeograph.

"Preliminary Report of the Quantities of Fruit Used by Pie Bakers." H. T. Badger, Oct. 1954. Paper presented at the American Bakers Assoc. Convention, Chicago, Ill.

"Distribution of Cold Pack Fruits and Berries to Bulk Users, 1953." H. W. Bitting, March 1955. Paper presented at the Convention of the National Assoc. of Frozen Food Packers, Chicago, Ill.

b. Household Purchases of Butter, Cheese, Nonfat Dry Milk Solids, and Margarine

MD

Since April 1954 monthly data on household purchases, prices paid, and related information for butter, cheese, nonfat dry milk solids, and margarine have been obtained from the National Consumer Panel of the Market Research Corporation of America. These reports are financed jointly by USDA and the dairy industry. Quarterly reports carry breakdowns by regions and by type of retail sales outlets. The annual report relates household purchases to family characteristics, such as occupation, income, and size of family.

c. The Institutional Market for Fresh and Processed Foods

MD

The report on the institutional market for fresh and processed foods has been completed and published. It evaluates the importance of penal, charitable, and mental institutions as an outlet for fresh and processed foods in terms of quantities consumed, expenditures, sources of supply, and outlines institutional purchasing policies and practices.

Publication:

"The Market for Food in Selected Public and Private Institutions." William S. Hoofnagle, Philip B. Dwoskin and James A. Bayton, Marketing Research Report No. 84, Agr. Mktg. Serv., USDA, Washington, D. C., March 1955.

d. Consumer Purchases of Fruits and Juices

MD

The survey of household purchases and prices paid for citrus fruit and products and their availability in retail stores has been continued in the past year. Monthly reports are published providing national estimates of volume of purchases by households, average prices paid, percentage of families buying, and average size of purchase. Quarterly reports present information by region and type of retail outlet. An annual summary of these data is made by family characteristics -- income, education, and occupation of the head of the household making the purchase. In February and August studies are made indicating the availability of citrus fruit and selected products in a national sample of retail food stores. Half of the funds for these data is provided by participating citrus industry groups.

e. Consumer Retail Acceptance of Fat vs. Lean Pork

CC

In recent years there has been considerable concern about the problem of surplus lard and the declining demand for pork. Farmers are being encouraged to produce a leaner type of hog. Because of the increased interest in lean pork, a study was designed to measure the response of consumers in self-service retail stores to fatter versus leaner pork. This was done by

offering side by side, center cuts, chops, and shoulder steaks from these two grades of port at varying price differentials. Measurement of consumer acceptance was based on the rate of movement of each grade at particular price differentials. All field work has been completed, and data have been tabulated. Results of the study are not available as yet.

f. Consumer Preference for White Pan Bread

MD

The research on determining consumer preference for white pan bread in respect to specific volume and content of lard, sucrose, and nonfat dry milk solids has continued during the past year. Results of this study are expected to be available in the early fall of 1955.

g. Consumer Preference for Canned Orange and Grapefruit Juices that Vary in Brix-Acid Ratio with Degree Brix Constant

MD

The results of the research to determine the brix-acid ratio level for canned orange juice within the commercially feasible brix-acid ratio that has highest preference among consumers have been published. A similar manuscript relating to canned grapefruit juice is being circulated for review.

Publication:

"Preferences for Canned Orange Juices That Vary in Brix-Acid Ratio", James A. Bayton and Hugh P. Bell, Marketing Research Report No. 76, December 1954.

h. Consumer Use of and Preferences for Peanuts and Tree Nuts

MD

The purposes of this study are to measure the extent to which peanut and tree nut products are used in households and to determine what attitudes, opinions and other factors influence consumption of these products by household consumers.

Plans: Interviews will be conducted in a representative sample of households throughout the country by a private marketing research firm under contract with the U. S. Department of Agriculture. It is expected that the results of this study will be available in 1956.

i. Consumer Use of and Preferences for Selected Cuts of Lamb

MD

The purpose of this survey was to evaluate consumer preferences for and attitudes toward fresh lamb in a selected marketing area wherein per capita consumption was believed to be relatively low. There has been little information of a qualitative nature available about the factors which influence the home consumption of lamb. A knowledge of the patterns of use and the opinions and attitudes concerning the consumption of lamb will indicate areas where additional promotion will most likely be effective

in improving sales of lamb and mutton, and will enable the industry to orient their advertising and sales promotion activities more efficiently. A published report of this research will be issued early in 1956.

j. Consumer Use of and Opinions about Different Kinds of Pies
and Uses of Canned and Frozen Cherries in Pie Baking

MD

This research project was undertaken in cooperation with the National Red Cherry Institute and the Cherry Growers, Inc., and was designed to provide background information about home-makers who bake pies, with special reference to those who bake cherry pies. The results will furnish growers and processors with information about consumer habits and attitudes that will be helpful in promoting the consumption of canned red sour pitted cherries. The results of this study will be published late in 1955.

V. RESEARCH AND EDUCATIONAL WORK ON BROAD OR

GENERAL WELFARE PROBLEMS

A. Progress on Work Underway

1. Food Distribution

a. National School Lunch Program

FD

Participation in the National School Lunch Program reached a record high of 11 million children during the 1954-55 school year. This was approximately 8 percent above 1953-54 participation, the sharpest annual increase experienced for any recent year. Over 1.8 billion meals were served in 1954-55, of which 80 percent were Type A (the complete meal with milk). Most of the remainder consisted of one half-pint of fluid milk -- the Type C meal. The Type B meal (a blanced but less substantial meal than the Type A) which is approved for schools with limited cooking facilities, now represents less than one percent of all meals served under the program.

The Department has been devoting considerable time to developing improved technical materials to assist local school lunch workers to improve the quality of meals served. By the opening of school this fall, a new card file (containing approximately 170 recipes) and a food buying guide will be available for distribution to participating schools. Later on in the year, a new guide for planning and equipping school lunchrooms is scheduled for publication.

b. Special School Milk Program

FD

Considerable progress was made during the past school year in increasing fluid milk consumption by children under the Special School Milk Program, which was inaugurated by the Department last September. The new program was authorized by the Agricultural Act of 1954.

As of April 1, over 47,000 schools had been approved for participation, of which more than 7,600 were newly constructed schools or schools without a prior service of milk. Although the program was not operating Nationwide in schools until December, well over 400 million additional half pints of milk were consumed by children under the program in 1954-55. Operating experience, however, indicated the need for modifications in the program to enable a larger number of schools to more effectively encourage increased milk consumption. Program changes for 1955-56 were announced by the Department in June to enable State educational agencies to undertake early planning for the 1955-56 program.

c Direct Distribution

FD

Over one billion pounds of surplus foods were moved into consumption channels in this country and abroad under the Department's program of Direct Distribution. This was 78 percent larger than the amount distributed in 1953-54.

Almost one-half billion pounds of surplus foods were distributed to users in this country, including 11 million school children, over one million needy persons in charitable institutions, and about 3 million needy persons in family units. The foods made available included butter, cheese, dry milk, canned beef, dry beans, rice, shortening, and several other commodities in limited amounts.

A total of 580 million pounds of surplus food was made available to U. S. private welfare agencies for distribution to needy persons overseas. The sharp increase in overseas distribution (from a total of less than 200 million pounds the preceding year) resulted from the liberalization of previous legislation which permitted greater latitude in the use of U. S. food stocks to aid needy persons in friendly countries overseas. During 1954-55, 19 U. S. private welfare agencies participated in the program for the shipment of food abroad with commodities going to 57 countries. The foods donated abroad included butter and butter oil, cheese, dry milk, and shortening..

2. Federal Extension Service and Its
Functions in Educational Work in
Food and Nutrition.

a. Home Economics Programs

FES

Relationship to the States:

Educational work of the United States Department of Agriculture is carried on primarily by Cooperative Extension work. The Extension Service functions under an agreement between the Secretary of Agriculture and the President of each Land Grant Institution. The agreement provides that the USDA shall conduct all cooperative extension work in agriculture, home economics, and related subjects through the Land Grant institutions except as otherwise mutually agreed and sets up the Federal Extension Service as the educational arm of the Department. The institutions agree to conduct all of the cooperative extension work in the States and such parts of other USDA programs as are primarily educational.

Financial support for cooperative extension work comes from Federal, State, and local sources--39% of 1955 funds were from Federal sources, 36% from the States and 25% from local sources. The program is administered by the State Director of Extension,

a staff member of the Land Grant institution whose appointment is approved by the Secretary of Agriculture.

The Federal Extension Service is part of the States-relation group of the USDA. Within the Federal Extension Service are 3 program divisions, the Division of Management Operations and the Division of Extension Research and Training.

The Division of Home Economics Programs provides consultative and direct assistance to State extension services in the appraisal and conduct of home economics programs.

From the beginning, extension educational programs have been planned with the people and designed to help people to help themselves--in this case to feed themselves and their families better than they are now doing.

The principle of working out programs with the people in each county is well established; the procedure varies from State to State and the results vary not only from State to State but from county to county.

Whatever the procedure, there are 7 common elements in our program planning:

- (1) Expression by many people in the county of what they believe is needed.
- (2) Consideration by staff and by local people of both the general situation and the local facts in relation to food and health.
- (3) Recommendation by extension workers and representative local leaders as to program or action that will provide help and can be carried out.
- (4) Decision by the organized groups in the county as to which recommendations they wish to follow.
- (5) Decision by key leaders and staff as to what should be done to reach others.
- (6) Development by staff and leaders of the agreed upon program.
- (7) Evaluation by the staff and key leaders as to what has been accomplished and what should be done next, which starts the cycle.

To lead in the development of extension programs in food and nutrition are:

1. Federal extension nutritionist, 35 State food nutrition and food preservation specialists, 3,865 home demonstration agents,

and 190,554 volunteer local leaders. There is a close working relationship with the food production specialists, the home management specialists, the consumer information specialists and the child development specialists in order to provide sound and well integrated teaching.

2. Program.

3. Evaluation.

b. Foods and Nutrition Program

FES

The general objectives of the food and nutrition program are to help families understand the relation of food to health, to develop and follow good food habits, and to know and understand selection of food for an adequate diet. More specific objectives are to help especially the homemaker and the 4-H Club girls to develop skill in food preparation and in serving meals that are attractive as well as nutritious; to understand and apply the principles of meal planning and realize the importance of happy mealtime, to make best possible use of home produced food; to learn to buy food wisely, and to store food in the home according to the best methods.

I. What subjects are most of the States offering?

1. Food preparation -- e.g. quick meals.
2. Food preservation -- e.g. meals from the freezer.
3. Food selection and buying -- e.g. best buys.
4. Nutrition for the entire family.
 - a. (e.g.) Feeding the pre-school child.
 - b. (e.g.) Feeding older people.
5. Planning the home food supply.

II. What methods do we use?

1. Group methods.
2. Mass media.
3. Individual contacts.

III. Who are the people we are reaching through

1. Group methods
 - a. Home demonstration.

- b. 4-H Clubs
 - c. Other organized clubs
 - d. The general public
2. Mass Media--T.V., Radio, Newspapers
- a. Urban
 - b. Low income.
 - c. Young homemakers
 - d. General public
3. Individual contacts
- a. Home visits and farm and home unit approach
 - b. Office calls
 - c. Correspondence.

IV. Who teaches nutrition?

- 1. Specialist.
- 2. County home demonstration and 4-H agents
- 3. Local leaders.

V. Contribution of Federal specialist

The Federal specialist emphasizes two or three important points each year that appear to be most important, in addition to assisting States to strengthen the general nutrition program.

- 1. Professional training for specialists and agents--summer school.
- 2. Workbook and various releases.
- 3. Help in States with programs--e.g. 4-H foods and nutrition programs and projects.

Research and Evaluation in Extension:

- 1. Why research in Extension?
 - a. The use of the scientific approach in solving extension problems.

2. Progress to date in Extension Research
 - a. Brief review of the development of extension studies since 1923.
3. Present organization of the Division of Extension Research and training.
 - a. Program research
 - b. Teaching methods research
 - c. Research relating to the organization and operation of the Cooperative Extension System itself
4. Future research in Extension.

Evaluation:

Research needed to determine nutrition situation for program development purposes may be field surveys, or it may be the assembling of factual information from many sources. Field studies or surveys are done (1) on food habits from dietary records of farm families, home demonstration club members, 4-H members, or other segments of a population, (2) present practices in all phases of food and nutrition work, (3) expenditures for foods, (4) amounts of and kind of home produced foods -- and many other topics

Factual data on foods produced, farm income, health, and other items basic to nutrition programs are assembled from census records, public health services, and other sources

A case example of a State nutrition program based on research follows:

In this particular State, dietary records were obtained and analyzed from:

A cross section of home demonstration club members
Fourth-grade children in more than $\frac{2}{3}$ of the counties in the State.
Teen-age 4-H Club members.

Results from dietary studies made by the public health department in the State were also used.

Related to the study of dietary habits was a study to determine to what extent home demonstration club members knew (1) the food groups needed daily, and (2) why these foods were needed by the body.

The studies revealed the major food groups needing emphasis in the State. In addition, there was definite evidence that the homemakers

who were included in the study needed more information on what foods her family should eat daily and why these foods were needed in the body.

With these facts as a background from a State level:

1. Needs were defined and interpreted as shown by the study
2. Results were sent to all counties for use in county program planning meetings.
3. County facts were used when available.
4. Teaching materials (program ideas, suggested topics, etc.) were prepared, placing emphasis upon foods lacking in the diets in the State.
5. Each county planning group was encouraged to study the survey results and to select one or more major problems for emphasis during a given year, and to set objectives in line with problems. Each county in the State selected the problem or problems for emphasis that seemed most feasible for that county
6. Many teaching methods were employed in the program. Again research indicates that several exposures are necessary for maximum adoption of practices. Teaching materials and methods used in extension are adapted for use with various educational and income levels. The method demonstration or illustrated lecture has proved to be the most effective method for teaching food and nutrition information. The teaching of nutrition information is usually very closely integrated with teaching foods.
7. Evaluation devices were developed for estimating progress made toward solution of the problems. Each county was asked to evaluate progress on programs chosen for emphasis in that county and to redirect programs as needed.

Extension nutritionists made every effort to help county home demonstration agents keep up to date on the latest research in nutrition from Experiment Stations, home economics departments, and other institutions engaging in basic research. This type of research forms the basis for much of the subject matter content of nutrition programs in extension.

Home demonstration agents and leaders are also supplied this information on current trends and outlook information related to nutrition.

c. Agricultural Economics Programs

FES

Consumer Marketing:

Consumer marketing information programs now being carried on by the Extension Service are a part of the overall educational work

in marketing. The consumer programs are concentrated in the major urban areas of the country. At the present time, there are programs in 39 States, Hawaii and Puerto Rico. There are 67 different projects. There has been a rapid and continuing expansion of work in this area.

These programs have as their objective maximizing the satisfaction consumers get from their food dollars. This is done by:

1. Giving food shoppers a know-how for getting more food value and dollar value from every dollar spent for food.
2. Improving food-buying practices that not only help the consumer but make for more efficient marketing of all agricultural products.
3. Developing consumer understanding of food marketing problems and processes, in-season supply, price and quality trends.
4. Developing consumer confidence in the service as a regular source of reliable, current information that assists them in making wise food choices in terms of family needs, food preferences, time and money available for buying and preparing, improved family health and satisfactions.

Most of the information is disseminated through radio, newspaper, and television. These programs are consumer oriented. In order to do this, advisory councils have been set up in most of the urban areas now having programs.

Consumer information programs in food marketing do tie to reliable information on nutrition.

While the majority of effort is devoted to reaching family consumers work is getting started in several areas to help food buyers for camps and also with institutions, especially those smaller institutions not having professional food buyers. In New York City, a special bulletin was prepared for the Puerto Rican group. This was done in cooperation with the City health and welfare departments.

At the present time, there are 90 consumer information workers. Their efforts are multiplied many times, however, through use of their material by county extension agents, health and welfare workers, commercial radio, television and newspaper people and the like.

B. Proposals for Committee Consideration
(Order of listing has no priority significance)

1. Production Research

- a. Insecticide Residues -- Expand work on insecticide residues including their toxic effects to plants and on soils. The lack of information on residues occurring in foods consumed by man and animals following the use of insecticides is still a major obstacle to the maximum utilization of new pesticides in the protection of agricultural products from attack by insects.

Increased funds for FY 1955 made it possible to establish a new chemical residue laboratory and to do some additional research work. However, there is great need for additional studies on the effects of various new insecticides on plants and soils, the determination of residues in and on plants and animals following insecticidal treatment, and on evaluating the effect of insecticides on quality and flavor of foods. This broad program is dependent upon research to develop chemical and/or bioassay methods for the determination of minute amounts of insecticidal residues and a sufficient staff to analyze thousands of samples to determine the residues present on or in plants and in milk and meat following the use of insecticides for insect control. Expanded work on insecticide residues is paramount due to increased public concern over hazards of pesticides and the greater responsibility of the Department of Agriculture in meeting the rigid provisions of Public Law 518 (Miller amendment) which includes recent tolerances established by the Food and Drug Administration.

- b. Mineral Interrelationships in Animal Nutrition -- Expand studies of relationships of mineral elements with each other and with other components of biological systems upon the nutritional status of animals.

Preliminary studies of the effect of zinc on one of the respiratory enzymes, cytochrome oxidase, stimulated this proposal last year, but funds have not become available to undertake this expansion. In the course of studies of the effect of high levels of molybdenum on the copper status of the animal, the observation was made that the sulfur amino acid, methionine, would alleviate the growth retardation produced in the rat. Hence, one of the first steps proposed is to study the effect of varying levels of molybdenum and copper on several sulphhydryl enzymes to determine how molybdenum and copper are interrelated in the metabolism of the animal. Such information is essential for an understanding of nutrient imbalances.

Studies of molybdenum toxicity in the laboratory animal should also be undertaken to provide data that will permit interpretation of the interrelationships of sulfur, copper and other mineral constituents of the plant and their specific effects on the absorption of molybdenum from the plant by the animal.

- c. Plant Sources of Vitamin B₁₂, and Factors Affecting Utilization by Animals -- Initiate research to ascertain plant sources and forms of Vitamin B₁₂ as well as environmental and cultural factors affecting their utilization by the laboratory animal.

It is generally considered that all plant diets are poor sources of Vitamin B₁₂. However, differences in a Vitamin B₁₂-like substance in turnip greens were responsible for substantial differences in the growth of rats. The other "B" vitamins are important constituents of the metabolic mechanism of most cells and organisms. Plants produce these vitamins and animals obtain them by ingestion of the plants. If Vitamin B₁₂ is comparable to the other "B" vitamins and functions in fundamental enzyme systems, then it should be more obvious in higher plants. It is, of course, possible that Vitamin B₁₂ occurs in another form in higher plants and this form is not suitable to all animals. One important question that arises is the nature of the substances which do give Vitamin B₁₂ activity in the L. Leichmannii test. Do these substances contain cobalt? Do they perform the functions in the higher plants that Vitamin B₁₂ does in the animal? Some plants, Nyssa sylvatica for example, accumulate very large quantities of cobalt, 100 to 1,000 times that normally found in other plants in any particular soil area. This species shows no Vitamin B₁₂ activity.

It is proposed to grow in sterile culture, several food crops and analyze them for Vitamin B₁₂ activity. Radioactive cobalt would be used. The unknown substances which have Vitamin B₁₂ activity would be isolated, characterized and fed to rats, rabbits, and other animals to confirm possible B₁₂ activity.

- d. Mineral Nutrition in Relation to Toxic Substances in Plants -- Initiate research to determine the effect of mineral nutrition on the content of toxic substances in plants.

In many areas, but particularly on the western cattle and sheep ranges, plants containing high concentrations of alkaloids, prussic acid, oxalates, nitrates and other poisonous substances are responsible for death of sheep, cattle and horses. It is believed that the degree of toxicity in any species may vary in different locations and it is quite certain that not all varieties or strains of the same species are toxic. Since variation in the nutrition of the plant can modify its amino acid composition, the same relationship may hold for the alkaloids, since these substances are formed from the amino acids in many cases. It is proposed to study the toxic principles in various plant species grown under different conditions of soil and climate to determine the peculiar growth conditions that may be promoting the production of unusually large quantities of the poisonous constituent. An accumulation of unassimilated nitrate in the plant may also be poisonous to the animal eating it.

2. Utilization Research

- a. Nutrients in New Foods. Expand analyses for nutrients in foods in order to develop data on all nutrients for new foods and new forms of common foods which are not now included in tables of food composition.

Commercial processing and modern marketing methods are responsible for many new food items about which nutritive value information is non-existent. Some are high-calorie, fat-processed ready-to-eat foods; others are formulated mixes for home cooking which are quite unlike household recipes in kinds and proportions of ingredients.

- b. Organic Acids in Foods. Initiate laboratory analyses to determine the kinds and quantities of organic acids in fruits and vegetables which affect other nutritive values.

Present tables of food composition treat all organic acids as carbohydrates in reckoning caloric values, but some are not metabolized for energy production by human beings, and some affect the utilization of calcium and other nutrients. Data on the quantitative distribution of predominating organic acids in foods are needed to improve the accuracy of values for calories and other nutrients, and would also provide clinicians with basic information needed in prescribing diets for some metabolic disorders.

- c. Dietary Factors Affecting Amino Acid Requirements. Expand research on the effect of type of carbohydrate in the diet on amino acid utilization to include other components of diet, and other biochemical and physical criteria of the nutritional effects.

Attention should be given to "non-essential" amino acids and non-protein nitrogen, as well as to "essential" amino acid ratios in the diet. The criteria should include, in addition to studies of nitrogen balance and calorie utilization, analysis of blood and other tissues by histological and chemical means. This information is basic for determining amino acid requirements of people consuming diets of different patterns.

- d. Long-term Effects of Dietary Combinations. Expand research on the effect of diet on adult efficiency and on premature physical impairment in laboratory animals.

This expanded work should include more intensive observations of the nature of the impairment encountered under conditions of recent experiments and should determine the nutritional imbalance involved. This research should provide also for study of histological and gross anatomical changes in the animal at all ages, more chemical analyses of blood and other tissues with particular attention to abnormal protein-fat fractions, and some analyses of the enzyme contents of vital organs and tissues with first emphasis on lipase in blood.

- e. Physiological Availability of Nutrients from Foods - Expand research to determine the physiological availability of nutrients from foods, and the extent to which food processing, other food constituents and diet patterns affect their availability.

Particular attention should be given to the physiological availability of amino acids from foods and diets. This work calls for digestibility and metabolic studies using human subjects, to supplement other methods for determining the extent to which nutrients are available from typical foods as commonly eaten. This information is needed for appraising the nutritional value of various diets.

- f. Fat in Human Nutrition. - Initiate research to investigate the role of fat in human nutrition, such as the relationship of the amount and kinds of fat to metabolism of other nutrients, determination of desirable upper and lower limits of fat intake in various nutritional situations, and the dietary precautions needed when fat in diets is unusually high or low.

This research is urgent in view of the growing evidence of the relation of diet to the development of renal-cardiovascular disease. Studies of aging persons and of laboratory animals on abundant diets have implicated high-fat, high-calorie diets in some disorders of metabolism. A war-time recommended level of fat in diet was 25 percent of the calories from fat, countries under economic stress often have levels below 20 percent; present level in USA averages about 40 percent, with well over 50 percent of the calories from fat in the diets of some individuals.

- g. Interrelationships in Consumption of Foods and Nutrients - Expand analytical work on the 1955 survey data on food consumption to show interrelationships (competitive and complementary) in the consumption of foods and nutrients--facts needed as background for nutrition education and for other programs of the food trades and the Department of Agriculture.

Few analyses have been made to show the effect of unusually large or small consumption of certain foods on the consumption of other food items and on the nutrient content of resulting diets. This knowledge is basic to understanding the potential effect that might follow increases in consumption of some products as a result of lower prices, nutritional recommendations, promotional programs or changes in marketing of foods.

- h. Trends in Household Food Consumption and Dietary Levels - Expand and accelerate analytical work on food consumption and dietary levels to make available more quickly conclusions as to changes between 1935-36, 1942, 1948, and 1955.

Survey data for these years will be available when the 1955 survey is completed, but to do the analysis promptly, expansion is needed. These analyses would answer such questions as the following: How much change has occurred in the proportion of the population with diets that meet the recommendations of nutritionists? Have

differences in this respect among income groups changed? Has the pattern of nutritional contribution of different foods changed? These analyses will provide data wanted by nutritionists, home economists, market analysts, the food trade, and the Department of Agriculture. Some retabulation of data from earlier years will be required because of new knowledge of the nutrient content of foods and of revised dietary allowances for these nutrients.

- i. Seasonality of Farm Family Diets— Initiate research to determine the extent to which farm family diets differ with season, for the interpretation of food consumption and dietary studies to nutrition education and Department programs, and to aid in the construction of the Department's Index of Prices Paid by Farmers.

A number of seasonal surveys in selected farm areas would materially strengthen the nutritional interpretation of farm family food supplies as indicated by the 1955 spring survey. Seasonal interpretation of conclusions was provided for the urban population in the 1948 survey, but is not available for farm families. It is expected that seasonal differences in consumption of specific foods, in food expense, and in nutritive value of diets would be greater for farm than city families.

- j. Household Food Losses— Expand the collection of weighed records of kitchen and plate discard from selected groups in the population working toward estimates that can be applied to surveys of representative households and institutions. In such studies, different approaches would be tried (such as limiting the record keeping to one or two commodities at a time) in order to develop methods that could be used with as many groups in the population as possible.

- k. Household Food Stocks for Civil Defense Planning— Initiate surveys to determine kinds and amounts of food stocked in rural and urban households to aid in civil defense planning of food for people to be evacuated from target areas.

A rough estimate, based on inadequate data, was made recently at the request of the Federal Civil Defense Administration in order to illustrate the problems involved. Needed are data on the kinds of food normally stocked by various population groups, the type of container or package and the portion of the stock in freezers. Surveys should be made that will permit study of the factors affecting stocks so that projections can be made under various assumptions of attack, safety of foods, use of electricity, etc.

- l. Food Budgets— Initiate research to construct food budgets based on current nutritional recommendations, food consumption patterns and food prices.

Food budgets to help families obtain nutritionally adequate meals at different cost levels have been published by the Department for more than 20 years. They are used by many groups in administrative

programs (especially public assistance) as well as in educational work, and by families in developing their own plans for food purchase and production. Revisions are needed from time to time because of advances in nutrition knowledge, and shifts in food habits, and relative costs of different types of food. A complete revision has not been made since 1948. Since then, the National Research Council has revised its Recommended Dietary Allowances and food habits and prices have changed considerably. The 1955 survey will provide up-to-date information on food consumption patterns. It is proposed that initial emphasis be directed toward preparing food budgets to meet the needs of Extension Service staff in the farm and home unit planning program.

- m. Food Qualities Affected by New Methods of Heat Processing— Initiate studies to determine the comparative effects of new and different methods of cooking on food qualities and nutritive values.

Such studies should include effects of rate, intensity and mode of heat application, such as effects of pressure cooking, electronic cooking, and other new processes available to institutional and household users. Information as to which foods, qualities and nutrients may be improved, and which may be damaged by some of the new methods of cooking is needed to guide household and institutional (including school lunch) managers and others responsible for food service.

- n. Quality and Safety of Frozen Foods— Initiate research to determine the effect of thawing and re-freezing on the quality and safety of frozen foods.

With widespread use of home freezers their ability to maintain refrigeration or safe-keeping temperatures will become an important factor in the problem of home storage of both home-prepared frozen foods and purchased foods stored at home. Investigations up to the present have been limited to studies of temperature changes occurring during periods of non-operation of freezers. Users of home freezers require information on the effect of subsequent re-freezing on the safety and quality of frozen foods. Samples of frozen foods typical of the various classes (fruits, fruit juice, vegetables, meats, and prepared foods) should be evaluated on the basis of bacteriological examinations of inoculated samples and both bacteriological and palatability tests on parallel uninoculated samples.

- o. Freezing Home-Prepared Foods— Initiate research to develop improved methods and formulae for freezing home-prepared foods and to facilitate efficiency in the management of food supplies and household manpower.

The procedures developed should insure food products safe from bacterial spoilage and fully acceptable to consumers, and determine safe practices in using or refreezing accidentally thawed foods. The demands of both farm and urban families for information on more efficient management of time and materials

in the preparation of foods for freezing require basic data not now available.

- p. Improved Cooking Procedures for Home and Institution.- Expand research to develop improved methods for home and institutional cooking as a means of maintaining or enhancing desirable qualities in foods, with emphasis on vegetables, fruits, and meats.

This research should include: (1) development of procedures best adapted to the foods of the many market qualities and new varieties now available, (2) modifications in cooking methods necessitated by differences in conditions encountered, such as hardness of water and altitude, (3) determination of physical and chemical constituents and characteristics in raw, cooked and home processed products that affect the cooking and eating qualities. Such research will assist consumers in making better use of market offerings and help to assure satisfaction at the "point of use."

- q. Palatability

Methods for Evaluating Palatability -- Initiate research to develop and standardize more rapid, reliable and reproducible laboratory methods, and procedures for the sensory evaluation of food quality.

The basic physiological, psychological, biochemical, and electro-chemical reactions involved in sensory methods of evaluating food quality should be investigated in order to better understand the mechanisms involved. Also, as a necessary part of sensory testing methodology, new and improved experimental designs and statistical procedures are needed. Parallel research to develop and standardize more satisfactory objective methods of measuring the physical, chemical, and histological attributes of foods should be carried out to supplement sensory evaluation of such quality factors as color, flavor, and texture of both raw materials and final product.

3. Marketing Research

- a. Consumption of Processed Foods -- Undertake an analysis of the current structure of the consumption of processed foods, to be related to available historical data on per capita consumption for major items and information on socio-economic factors affecting the use of processed foods.

This information is needed to formulate better bases for forecasting future changes in demand for specialized marketing services purchased with food commodities. Source material for this analysis will include data from the new Censuses of Manufactures and Distribution, the survey of use of processed foods by restaurants, and the 1955 survey of household food use which will become available early in 1956.

- b. Increased Consumption of Milk Among the School Population -- Expand studies recently initiated to determine the most effective method or methods of increasing the consumption of fluid milk among the school population.

These studies are related to legislative authorization for a school-milk program and are based on the premise that increased consumption of milk in schools will have a two-fold effect in alleviating the surplus milk problem and in providing nutritional benefits. This research is designed to provide the following information: (1) amount of price reduction required to obtain a maximum increase in milk consumption within the limit of funds available; (2) most effective methods of operating the school-milk program, including methods of sale, sizes of containers, pricing units, and also including the extent to which cooperation might be obtained from the dairy industry in the form of special prices, services, and promotional leadership; and (3) the results that might be derived from such a program in terms of total participation, increase in total volume of consumption, and operating costs.

- c. Basic Research on the Evaluation of Quality and on Quantity Relationships in Agricultural Commodities and Their Products -- Initiate basic research on the evaluation of quality and on quantity relationships in agricultural commodities and their products moving in market channels.

Basic research is needed on quality evaluation of agricultural commodities moving in marketing channels to determine the biochemical constituents and physical structures responsible for high quality. Too little technical information is at hand concerning the compositional and structural factors that account for the color, flavor, texture, and other quality attributes of farm products. Studies to provide this basic information is needed for the development of new and improved methods of quality evaluation. Better methods of quality measurement will benefit producers, distributors and consumers alike because they will aid not only in the establishment of sound grades and standards but also in quality control and quality maintenance programs.

Further basic information is needed concerning the quality relationships between raw products and their corresponding processed or end products. This should yield findings of value to growers, processors and manufacturers who are constantly faced with situations where official standards and other means of quality evaluation in buying and selling fail to supply accurate information directly related to the quality or value in terms of intended end use. The principles of these quality relationships are important not only with food for human consumption, but also with feed for livestock and fibers for manufacture. The wide variety of alternate uses for many of our farm commodities naturally presents an extremely complicated situation in the establishment of quality standards based on utility values of the commodities.

Accuracy of quality appraisal could be improved significantly in many instances if present subjective methods, relying heavily on human judgment, could be replaced by objective or instrumental methods of quality measurement. The development of such methods will require research to discover product characteristics that can be measured rapidly and accurately and exhibit a high degree of correlation with specific quality factors. For example, many chemical constituents of a given crop can be measured easily and the level of one or more might serve as a measure of product quality, but research is necessary to establish whether a significant correlation exists. New constituents whose isolation and identification awaits the application of our modern techniques, might also be used for this purpose. Another approach would focus attention on the physical attributes of quality by studying the instantaneous interaction of the product with ionizing radiations, and with light, mechanical and ultrasonic energies. By analyzing the response to such radiations and vibrations, physical characteristics of the product can be measured and correlated with product quality.

It is proposed that this research will be initiated or expanded in the following fields in accordance with specific application to the commodities involved: (1) citrus fruits, (2) cotton, (3) deciduous fruits, (4) dry beans and peas, (5) grains, (6) livestock, (7) potatoes, (8) poultry, (9) seeds, and (10) vegetables.

- d. Practical Instruments and Techniques for Maturity and Quality Measurement of Food Crops -- Expand research to develop instruments and objective quality tests for measurement of maturity, color, texture, and other important quality factors of agricultural commodities for the fresh market and for processing.

The value of rapid objective quality measurement is already generally recognized by many segments of the food industry and wide use is made of such instruments and methods as the moisture meter, tenderometer, pressure tester, photoelectric colorimeter, and fat acidity test. These instruments and techniques reduce the element of human judgment by providing an accurate objective basis for quality determination. Improved instruments and techniques for identifying and measuring quality not only expedite buying, selling, and pricing but they represent invaluable tools for following quality maintenance and improvement programs. Comments from marketing agencies, distributors, processors,

and producers indicate the need for further refinement of methods or redesign of instruments for new applications in many instances. Entirely new devices employing electronic or mechanical principles are needed in other instances. It is recommended that when possible instrumentation be developed to the point where performance is automatic. Cognizance should also be taken of the desirability of employing procedures that are non-destructive to the commodity. For this purpose, spectrophotometric principles, ultrasonic vibrations, and electromagnetic radiation, for example, may be of great value. The use of such methods can provide means for measuring color, texture, and other quality characteristics of commodities and also provide the principle for automatic quality sorting devices.

It is proposed that this research will be initiated or expanded in the following fields in accordance with specific application to the commodities involved: (1) citrus fruits, (2) deciduous fruits, (3) dry beans and peas, (4) grains, (5) livestock, (6) oilseeds, (7) rice, (8) seeds, (9) vegetables.

- e. Time-Temperature Tolerance Investigations of Fresh Fruits and Vegetables -- Initiate studies on time-temperature tolerance of fresh fruits and vegetables.

Fruits and vegetables are exposed to varying temperatures as they move from the farm to the consumer. Exposure to temperatures above or below the optimum are believed to be cumulative in their effect on deterioration. More information is needed on the tolerance that various perishable commodities have to adverse temperatures and the changes in quality characteristics that are caused by such exposures. In a general way it can be said that apples ripen as much in 1 day at 70°F. as they would in 10 days at 32°; hence even a day or 2 exposure to high temperatures would have an effect on potential market life. It would be valuable to have data to give danger limits for accumulated exposures to adverse temperatures. The variables to be studied are numerous and would require large scale tests over a long period. The data obtained would be valuable as a basis for improving harvesting, handling, storage, transportation and marketing procedures.

- f. Post-Harvest Physiological Disorders of Fruits, Vegetables and Other Crops -- Expand research on post harvest physiological disorders of fruits, vegetables, grains and seeds that cause loss in nutritional value in market channels.

Physiological changes can markedly affect appearance, palatability and hidden quality such as nutritional value. During growth and development on the farm, fruits, vegetables, and other crops undergo progressive changes which in most instances reach optimum conditions at certain pick-times. Sometimes, chemical composition alone supplies an insight into the quality state or market value of a product, but there are many other factors of a physiological or biochemical character which have equally important bearings on retention of high quality and storage life. Metabolic changes associated with growth and maturation continue even after harvest until a product, having reached its normal span of life, quickly deteriorates to the point where

breakdown occurs through autolysis (chemical action) or through the medium of spoilage organisms, or both. Many factors influence the rate at which products develop such physiological disorders. Highly perishable foods, like fruits and vegetables have a relatively short span of life after harvest, other products last months and sometimes years as in the case of grains and seeds. These changes are steadily going on whether a product is in storage, in transit, or in any other steps associated with distribution in market channels. It is very important, therefore, from the standpoint of preventing waste, spoilage and loss in nutritional value, that basic studies on post harvest physiology be expanded to gain more definite knowledge of those factors which accelerate favorable processes and of those which retard the ones leading to ultimate destruction. Research in this field would include progressive changes in composition under different environmental conditions and stages of maturity, mechanisms of enzyme action, and other processes such as respiration and the effect of volatile emanations. A better understanding of post harvest physiology in its broadest aspects would aid in the determination of factors responsible for longer and better keeping quality.

It is proposed that this research will be expanded with (1) citrus fruits, (2) deciduous fruits, (3) vegetables, (4) potatoes, (5) grain, and (6) seeds.

- g. Control of Post Harvest Diseases and Deterioration of Fruits, Vegetables and Other Crops -- Expand studies on the control of post harvest diseases in fruits, vegetables and grains during marketing to prevent deterioration and loss of quality.

In the marketing of agricultural commodities each year many tons of fresh fruits and vegetables and other crops are damaged or destroyed by disease between the time they are harvested and the time they reach the consumer. Losses are more pronounced with highly perishable products like fresh fruits and vegetables, but with longer lived commodities like grains and seeds substantial losses also occur through mold and other causes. It is believed that the annual losses through market diseases alone amount to well over \$300 million. A very substantial portion of the losses presently experienced in the marketing of farm crops could be prevented and product quality improved if research overcame deficiencies in our knowledge of the causes and developed methods for their control. Important phases of this research have direct bearings to storage, transportation and food distribution problems and are involved with nutritional aspects as well. Such studies are conducted to obtain basic information from the standpoint of disease occurrence, identity, causes and control. The fungi, bacteria or other microorganisms are isolated, identified and thoroughly studied with respect to habits, where they live and how they infect or contaminate the commodity. A determination is also made on organism development through the study of the effect of various factors such as temperature, humidity and other conditions. The information obtained is essential in developing handling, storage, transit and refrigeration practices and treatment designed to avoid occurrence, or to inhibit development of post harvest deterioration from such causes. Treatments include fungicides, bacteriocides,

antibiotics and use of ultraviolet, infrared and other rays for sterilizing purposes. All of these are tested for effectiveness, safety and their effect on such characteristics as appearance, odor, taste, wholesomeness and nutritive value of the products treated. Further basic studies are needed to obtain a better understanding of the factors that favor infection and development of decay. Further expansion is also needed in the search for better fungicidal treatments and improved methods of application. The use of irradiation for decay control should be thoroughly explored.

It is proposed that this research will be expanded with (1) citrus fruits, (2) deciduous fruits, (3) vegetables, (4) potatoes, (5) grain, and (6) seeds.

h. Prevention of Deterioration of Meat, Poultry and Eggs -- Expand research on the prevention of deterioration of meat, poultry, and eggs during transportation to assure more efficient marketing.

- (a) Meat: Fresh meat, which is the best example of material stored in a non-living state, is highly perishable even at 45°F. The rate of change is less at slightly above the freezing point, but spoilage still goes on. Many factors are involved in the preservation and distribution of meat, since the different types vary in their ability to withstand chill-room storage and in the rate they change during cold storage. Pork is usually more susceptible to deterioration than other types. Deterioration may be from microorganisms or from decomposition caused by autolysis (chemical action). With improper handling, storage and transportation, these processes may ultimately reach the point where the product is unfit for human consumption. Salting, smoking, drying, and freezing are employed to prevent bacterial action, retard enzyme activity and reduce the possibility of rancidity, but there are many gaps in our knowledge concerning the reactions taking place. Research to gain more basic information should be initiated on (1) nature and behavior of microorganisms responsible for spoilage, (2) nature and effect of autolysis, (3) effect of animal age and other preslaughter factors on composition and susceptibility to quality change, and (4) relation of these matters to keeping quality and to storage and transportation requirements, such as time, temperature, humidity and packaging.
- (b) Poultry: An important problem in the poultry industry is the prevention of microbial contamination and spoilage, which results in off-flavors, rancidity and decreased shelf-life of ice packed or air chilled poultry. Research can contribute to the solution by accumulating basic information on poultry composition, effect of various factors on constituent reactions and on final quality, and by evaluating factors that relate directly to bacterial deterioration after killing, both in the handling plant and on the market. Solution of problems rests primarily in a thorough understanding of the causes and nature of the changes occurring in the handling, storage, transportation and distribution of poultry after killing. Biological research can research can reduce microbial spoilage and assure wholesomeness by studying

the causal organisms and by knowledge of the factors contributing to high contamination. Such information will lead to the development of means for inhibiting microbial growth and for assuring longer storage or shelf-life, which in turn will result in better handling practices and in improved poultry quality.

- (c) Eggs: Because shell eggs are relatively perishable and difficult to market, attempts have been made to extend their market life without sacrificing quality. The results have not been satisfactory, as evidenced by the fact that in some places eggs which averaged 90% double A grade at the farm decreased 16 to 17% in quality between the farm and city. In New York State 90% of the eggs are grade A for purchase, but upon inspection only 34% were actually grade A or better, which indicates a further decrease in quality at the retail level. Under present conditions the average egg available to consumers is about the equivalent of grade B. The inability to adequately control loss in grade arising from both microbial and non-microbial deteriorations, results in serious loss to the industry and to the user. Further basic knowledge must be acquired on bacterial penetration, growth and survival characteristics, and on non-microbiological changes such as thinning of the white and weakening of the yolk membrane. These matters affect quality and grade and result in a shortening of market life. Attention to these problems should lead to improved handling practices, better storage conditions and to better grades at the consumer level.

- i. Control of Insects that Infest Stored Agricultural Products -- Expand research on the control of insects that infest stored agricultural products, in order to prevent wastage and to preserve the wholesomeness of food products manufactured from them.

Control of insects in stored agricultural products under our present day conditions and standards, is a very important factor in the cost of our food products, our available supply of them, and their wholesomeness. Because of our current desire for flour, milled products, corn meal, etc., to be free from insect fragments, measures to prevent infestation in the grains used for these purposes are necessary. New storage practices and facilities, cost factors, and better utilization of labor emphasize the urgent need for new and streamlined insect control procedures which are more adaptable and less expensive. Until such methods are developed and universally adopted, many lots of grain will not meet Food and Drug Administration standards for millable grain and must be diverted to animal feed purposes. Insecticides must be used in a manner so that no insecticidal residue appears in the food product, or if so is within an established tolerance limit that has been set up under the Miller Act. (Public Law 518). In addition to establishing insecticidal efficiency of any preventive method, which has long been the object of Department research, the determination of the degree of residue for each use on each commodity must now be assumed. These problems have taken on a magnitude that increases in tremendous proportions each year to a degree that far outdistances the limitations of present funds and

personnel. Work in this field of research includes studies on insects that infest stored grain, stored rice, stored seeds, dairy products, feed products, dried fruits, nuts and nut meats, and farmers' stock peanuts.

- j. Development of Insect-Resistant Packaging -- Expand research on the development of insect-resistant packaging in order to prevent wastage and to preserve wholesomeness of food and other products.

The general public does not accept the presence of insects in packaged food commodities purchased, and industry has gone to great expense in attempts to develop packages that will prevent insect invasion. In practically all instances the strictly mechanical means of a tightly constructed package is depended upon to attain this end, and only partial success has been achieved. The wastage of food as a result of insect infestation is very large, since the presence of any insects at all usually results in discarding the entire contents of a package. The Food & Drug Administration estimates that 110 tons of food products are seized each week because of insect or rodent contamination while in trade channels and these seizures represent only a fraction of the actual infestations, since inspections are necessarily limited. The large number of packages returned to processors because of insect infestations is also an indication of the magnitude of the problem. Better packaging that will exclude the insects without affecting the wholesomeness of the food product is one part of the answer to this loss.

Extensive research done for, and in cooperation with, the Army Quartermaster Corps over the past five years on insect-resistant packaging, which has recently been published, has caused great interest in the food packaging trade, and has brought offers of cooperation from industry. Publication of the results to date has also pointed up the areas in which new research is badly needed. Industry depends almost wholly on the Department research for guidance in the choice of insecticides or repellents, determination of the residue problem, study of migration of the insecticide into the product, and related work. Probably no field of research promises greater return if an acceptable insect-proof package can be developed, nor in turn is there one of greater complexity and difficulty.

Research would be conducted on insect-resistant packaging for dairy products, dried fruits and nut meats, feed products, cereal, flour and grain products, milled rice, and seeds.

